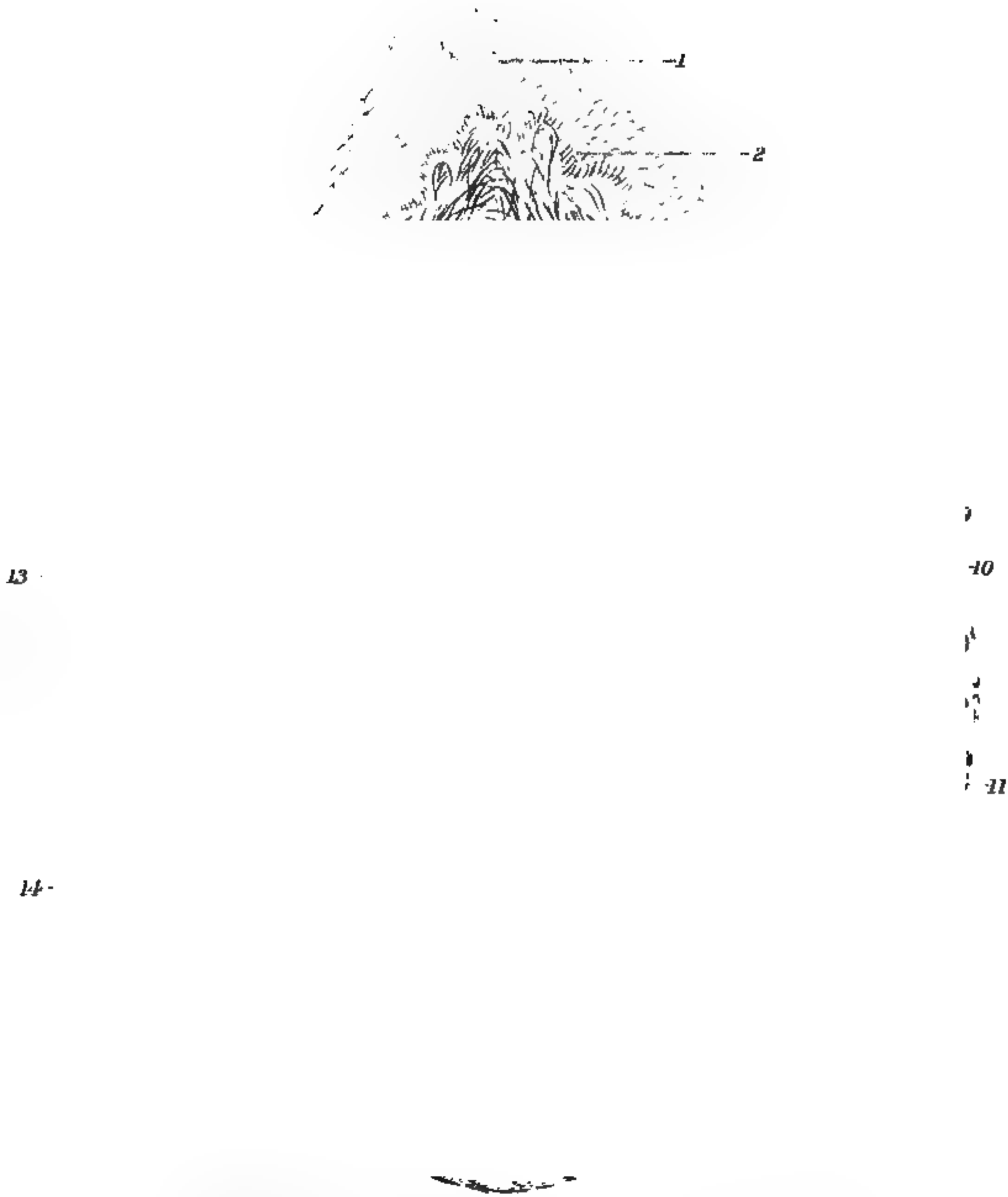
THE

PRINCIPLES AND PRACTICE

OF

DENTISTRY.



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THE PRINCIPLES AND PRACTICE OF DENTISTRY

INCLUDING

ANATOMY, PHYSIOLOGY, PATHOLOGY, THERAPEUTICS, DENTAL SURGERY AND MECHANISM.

BY

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Twelfth Edition.

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WITH ONE FULL-PAGE PLATE AND ONE THOUSAND AND TWENTY-EIGHT ILLUSTRATIONS.

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EDITOR'S PREFACE

TO THE

TWELFTH EDITION.

THE reputation and success of this text-book as an elementary treatise on the principles and practice of dentistry have been so apparent, and so universally recognized for many years by the practitioner and student, that no words of commendation on our part need be said. It has reached every civilized country and been translated into several languages.

The rapid advance of dental science, without a parallel when compared with that of other professions, has necessitated repeated additions, until the present volume has attained a size greatly above any that has preceded it.

In presenting the twelfth edition, it is with the hope that the efforts made to render the work such that it may receive the kind approval so generally bestowed upon the editions that have preceded it may be appreciated by those for whose benefit it has been prepared. It is an encouraging fact that the eleventh edition was exhausted some months before the present one was ready to be issued.

Additions have been made to almost every chapter, and new matter added to such an extent that this new edition contains, notwithstanding omissions deemed necessary, some *two hundred and twenty-six pages* more than its immediate predecessor. *Three hundred and eighty-two* new illustrations have also been added and considerable changes made in the general arrangement of subjects, all of which it is hoped will increase its value as a text-book.

A number of systems not before published in works of this character appear in the present volume, and every effort has been made to sustain the reputation heretofore accorded to it by the dental profession.

The editor and publishers are under many obligations to dental practitioners of recognized ability and reputation for systems of practice of which they are the authors; and also to the S. S. White Dental Manufacturing Company, the Welch Dental Company, Samuel A. Crocker & Company, through whose courtesy many of the valuable wood-cuts which appear in the present volume were furnished, and which greatly add to its value as a text-book.

FERDINAND J. S. GORGAS.

HAMILTON TERRACE, BALTIMORE, MD.,
February 1st, 1889.

EDITOR'S PREFACE

TO THE

ELEVENTH EDITION.

THE first edition of Chapin A. Harris's "Principles and Practice of Dentistry" was published in 1841, and from that date it has been the principal text-book in all dental schools.

The last or tenth revision was issued under the careful supervision of the late Professor Philip H. Austen, M.D., D.D.S., assisted, in the parts relating to anatomy and physiology, by Dr. Thomas S. Latimer, and in parts relating to pathology and surgery, by the editor of the present edition. As the ten years prior to this revision had nearly revolutionized dental mechanism, Professor Austen found it necessary to almost re-write the portion of the work relating to "Mechanics," and its superior excellence was universally acknowledged.

Nearly fourteen years having elapsed since this was done, the rapid advances made during this period in Dental Histology, Pathology, Surgery, and also to a considerable degree in Mechanism, have necessitated another revision, and at the request of the author's family and of the publishers, the editor has alone undertaken the task of revision, and the present edition is the result of more than a year's labor. This duty has been assumed with the hope that an experience of over a quarter of a century as a teacher in dental schools, and also as a dental practitioner, may have furnished the qualifications for such an undertaking.

The time which has elapsed since the first appearance of the tenth edition has necessitated a greater revision of this work than has been the case with any former edition, and the task of preparing an entirely new work would have been no greater.

Considerable changes have been made in the general arrangement of subjects; a number of entirely new chapters have been added in the consideration of subjects not even alluded to in former editions; additions have also been made to the text of nearly every chapter, some of the latter being far in excess of the original text.

The number of illustrations has been greatly increased, and the new matter now inserted has brought the work fully up to the time of its publication.

Obsolete theories and processes, together with unimportant details, have been omitted and more useful matter substituted. The aim of the editor has been to meet the demands of the present advanced state of dental science.

The new matter added includes: The Development of the Bones of the Head and Face; Temporo-Maxillary Articulation; Description of Mucous Membrane; The Origin and Development of the Teeth; Analysis of Tooth Structures; Secondary Dentine; Dentition; Calcification and Decalcification of the Teeth; Alveolar Pyorrhœa; Aphthous Stomatitis; Thrush; Sanguinary Calculus; Malformed Teeth; Effects of Syphilis upon the Dental Structures; Caries of the Maxillary Bones; Sensitive Dentine; Theories as to the Cause of Dental Caries; Treatment of Dental Caries; New Methods, Materials and Instruments Employed in Filling Teeth and other Operations; Electric Mouth Lamp; Electric Mallet; Dental Engines and Attachments; Rubber Dam Appliances; Treatment and Appliances for Correcting Irregularity of the Teeth; Contour Fillings; Replantation and Transplantation of Teeth; Different Methods of Inserting Artificial Crowns on Natural Roots; Bridge-Work; General and Local Anæsthetic Agents; Improved Forceps; New Materials and Trays for Impressions; Articulators; Blow-pipes; Furnaces; Celluloid; New Apparatus for Vulcanizing Rubber and Moulding Celluloid; Repairing Vulcanite; Duplicating Dentures; Theory of Vulcanizing; Regulators; Gold Alloy

and other Cast Bases; Temperament in Relation to Natural and Artificial Teeth; Improvements in Porcelain Teeth; New Splints for Fracture of the Jaws, etc., etc., etc.

The editor desires to acknowledge his indebtedness to Drs. George B. Snow, James H. Harris, Charles L. Steel, W. Storer How, and D. Genese, for valuable suggestions; and also to the writings of Drs. James W. White, Frank Abbott, J. Foster Flagg, John Tomes, Charles Tomes, Henry Sewell, Henry W. Williams, C. N. Peirce, W. D. Miller, G. V. Black, George Watt, J. L. Williams, James B. Dexter, Norman W. Kingsley, Theo. F. Chupein, J. N. Farrar, W. C. Barrett, J. D. Hutchinson, W. G. A. Bonwill, A. W. Harlan, C. T. Stockwell, the late M. A. Dean, M. H. Webb, and others. The courtesy of The S. S. White Dental Manufacturing Company, Johnson & Lund, Snowden & Cowman, Codman & Shurtleff, The Buffalo Dental Manufacturing Company, Spencer & Crocker, Ransom & Randolph, Gideon Sibley, and Dr. Norman W. Kingsley, is acknowledged, for the use of many valuable wood-cuts.

The Eleventh Edition of Harris's "Principles and Practice of Dentistry" is submitted to the profession, with a hope that it will be found a useful elementary treatise, a text-book for the student, and a reliable guide for the dental practitioner.

FERDINAND J. S. GORGAS.

BALTIMORE, January, 1885.

PREFACE

TO THE

SECOND EDITION.

In submitting to the profession a Second Edition of his Dental Practice, the author is happy to avail himself of the opportunity to express his grateful appreciation of the approbation which the First has received. He trusts that the additions which he has made to the primary work will make the one now presented still more acceptable. The alteration in the plan, which has resulted from the effort at improvement, has, however, rendered a slight change of title necessary, in order to express the character of the present book.

In the First Edition the Anatomy of the Mouth was omitted, because a thorough knowledge of it can be obtained from works on General Anatomy. But it has been suggested that such works may not be at hand when wanted by the dental student, and the author has thought it better to furnish a description of the several structures which enter into the formation of this cavity. He, has, however, confined himself to brief expositions of the parts; not wishing to encumber the work, or distract the student with the consideration of matters foreign to the purpose for which it was written, and for which, he trusts, it will be read. He is indebted to Bourgery's Anatomy, Quain and Wilson's Anatomical Plates, Wilson's Anatomy, and Smith and Horner's Anatomical Atlas, for a number of the illustrations used in this part of the work.

The Second and Fifth Parts embody the substance of two papers by the author, which were written subsequently to the publication of the first edition. The subjects of them came properly within the plan of the present work.

The object of the author in the preparation of this edition has been to provide a thorough elementary treatise on Dental Medicine and Surgery, which might be a text-book for the student and a guide to the more experienced practitioner; and he hopes that the modifications he has introduced, and the additions he has made, will entitle it to be so considered, at least, until an abler hand shall prepare a better.

CHAPIN A. HARRIS, M.D., D.D.S.

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CHAPTER XVII.

INTRODUCTION.*

DENTISTRY is the Science and Art of Medicine applied to the Dental Organs. Placed at the beginning of the alimentary canal, these organs hold an important relation to the digestive function, and through it, to the entire body. They have also inseparable connections with the nervous, circulatory and respiratory systems. Hence, whilst their preservation constitutes an important Art in medicine, the Science which teaches their structure, functions, diseases and treatment must necessarily be comprehensive. It must include those sciences which lie at the foundation of all medical art, and embrace so much of physical, mechanical and æsthetic science as its specific duties demand.

The Anatomy, Physiology and Pathology of dentistry differ in no respect from that taught in medical schools. The limits of a special text-book or curriculum of study, or a curtailment of the term of preparation, may require the omission of some details, to give opportunity for a fuller exposition of others; but a dentist's knowledge of these fundamental sciences admits no limitation, except that imposed by mental capacity. A single volume upon the "Principles and Practice of Dentistry" must of necessity be rigidly eclectic in those sciences, each of which occupies many volumes for its full exposition; whilst it must give, in complete detail, all applications of science to its specific duties. Again, the eclecticism of teaching, both in the office and the college, is dependent upon the time over which it extends. Thus neither printed, oral nor demonstrative systems of instruction can be taken as any correct measure of the amount of knowledge essential to professional excellence; for, in most cases, the knowledge thus gained is insufficient to give full value to the subsequent lessons of experience. The problem of professional education is one of difficult solution. While European systems seek to make "experts" of students, American systems are content to make them "experimenters." The Old World regards three or four years of extra study a small matter,

* This excellent introductory Chapter was prepared for the tenth edition of this work, by the late Professor P. H. Austen, the editor of that edition.

compared with the lives and welfare of the community; the New World considers any risk preferable to such delay in entering upon the practical duties of life.

The Therapeutics of dentistry, unlike its anatomy, physiology and pathology, differs from that taught in the medical schools. It is Medical, Surgical and Prosthetic. In so far as it is a direction of medical science to the prevention, modification or removal, by medicinal and hygienic remedies, of the causes and effects of disease in the dental organs, it forms part of a physician's practice, just as does the treatment of cerebral, cardiac, or pulmonary disease. In so far as it is an application of surgical skill to the extraction of teeth, the removal of tumors, to the treatment of fractures or to staphylorraphy, it is simply Oral surgery, involving only such knowledge and skill in the use of instruments as every surgeon must possess. But dental therapeutics includes a class of operations not taught in medical schools and not practiced in the offices of physicians or surgeons; which, for their successful performance, require surroundings and appliances such as no other class of operations call for; demanding also an amount of time and special experience which it is impossible for the general surgeon to devote to any one part of the body. Hence, by universal consent, this branch of therapeutics, under the name of Dental Surgery, is assigned to a special class of practitioners, who, like the oculist and obstetrician, perfect their art by limiting the sphere of its duties.

The prevailing and distinguishing feature of dental therapeutics is Prosthetics—the art of replacement; replacement of dental *structure*, in such manner and with such material as shall prevent further action of the destructive agencies; replacement of dental *organs*, by substitutes which shall physiologically restore impairment of function and æsthetically restore the natural expression of the face. The medical therapeutics and oral surgery of dentistry are insufficient to establish it as a distinct branch of medical art; whilst the operations of filling and regulating the teeth form a small proportion of its specific duties. It owes its extent to the universal liability of the teeth to decay and loss; it owes its difficulty, as an art, to the complex nature of the methods by which this loss and decay must be remedied. In other words, Prosthetic Mechanism constitutes by far the largest and most difficult part of dentistry, makes it a distinct branch of the art of medicine, and gives to it the power to add, as it does, to health, comfort and the enjoyment of life.

The physician, surgeon and dentist have necessarily many practical duties in common; but each has a clearly-defined limitation of sphere, requiring specific direction of that general culture which

all must possess. The Physician is a specialist; for, although he treats diseases which affect more or less the entire body, his therapeutics is restricted to hygiene and the materia medica, and there are many accidents, defects, and pathological conditions, which are beyond the reach of his skill. Moreover, the physician's specialty tends constantly to subdivision; nor do we look for the most valuable contributions to medical science, except from those who apply themselves exclusively to some one class of diseases. Few minds can even approach that universality of genius which characterized Hippocrates and John Hunter; hence devotion to a specialty of medical art detracts nothing from the position which a man's education and talent entitle him to assume.

The Surgeon is a specialist, although few confine themselves to a practice purely surgical, except in cities and hospitals. Richerand correctly defined the specialism of surgical therapeutics as the "*quad in therapeia mechanicum;*" its well-known etymology conveys the same idea. Yet the element of mechanism and necessity for the exercise of "hand-craft" enter, more or less, into all physical sciences. Astronomy, chemistry, pharmacy, microscopic analysis and modern medical diagnosis demand extreme accuracy of manipulation; and all great discoverers in these sciences display the ability, not only to use, but also to invent and construct apparatus. The universal recognition of the great value of this element in every department of Physics has given the scientific world a more correct idea of the true dignity of highly-educated mechanical skill —skill, without which the physician's art is crippled, surgery becomes impotent and dentistry has no existence.

The two departments of dental prosthetics, Structural and Organic, are usually classified as Operative and Mechanical dentistry. We have given preference, in this work, to the terms dental Surgery and dental Mechanics. Another classification is dentistry of the Chair and dentistry of the Laboratory. Each of these three classifications indicate prevailing characteristics, but all fail to point out the true basis both of the unity and the diversity of the two branches of dental practice.

As medicine and surgery are combined in the practice of the majority of medical men, so the two classes of prosthetic mechanism are usually practiced together; but such practice, although in a large number of cases unavoidable, does not tend to the development of highest excellence in either department. Certain details of the laboratory unfit the hand for some of the more delicate operations of structural prosthetics; whilst the engrossing and more remunerative duties of the chair almost inevitably lead to a hasty

and negligent performance of laboratory work. The usual method of meeting this difficulty, that is by dividing the duties of organic prosthesis, cannot be too severely condemned. It is like requiring an artist to paint a correct portrait from verbal description; it ignores every principle of dental æsthetics, and its results are artificial dentures so devoid of expression and individuality as to mar the features they are intended to adorn. But the prosthetic character of dentistry subjects it to a danger more serious than this unwise division of inseparable duties.

Scientific mechanism implies not only skill in construction, but judgment and purpose in application. Unfortunately a few months' use of tools enables one who has natural aptitude in handling them to produce specimens of workmanship which are accepted as evidence of peculiar fitness for dentistry. If no early education has given habits of study, the fascinations of hand-work are permitted to engross time that should be given to the harder and more distasteful head-work. The training, thus commencing and ending in mechanism, is discreditable, not because of its mechanism, but because, being one-sided and partial, it necessarily fails to accomplish that which it promises. Such training may make dental laborers, tradesmen, or artisans; but never dental artists, or scientific mechanicians; nor can the dentistry which they practice be, in any respect, identified with that which we have defined as a branch of the art of medicine.

A preparation begun in pure science may end in correct practice, and the early habits of student-life may follow the professional man throughout his career; but a preparation begun in practice will end there. The routine of professional duties often tempts the scholar to sink into the mere practitioner; it is rare indeed that one reverses the order of nature and sets aside the claims and emoluments of practice, to acquire slowly those habits of study so easily learned in youth. It requires the broadest literary and classical education of boyhood to counteract the necessarily narrowing influence of the professional studies of manhood; and it demands the largest possible infusion of purely scientific teaching, during professional pupilage, to correct the matter-of-fact influence of practice. In this lies the great error of American practical systems of education. They teach boyhood to take a utilitarian view of every lesson learned, and encourage young men to neglect studies in which they cannot see some prospective pecuniary value. It is the application to science and art of that philosophy of life which subordinates mind and body to the one idea of making a living; that spirit of trade, which regards classical study a waste of the years in which

plastic youth can best be moulded into the mercantile idea of Profit and Loss. Limitation, first in the amount of mental culture, secondly in its direction, is thus made to combine with the inevitable influence of all exclusive pursuit, whether of science or business; the result is a rapid increase, in all professions, of men whose vision is limited by the narrow horizon of their special occupation, and who possess none of that large-minded liberality which is the outgrowth of a generous education. It is by such early restriction of thought and action within the narrow grooves of life's future pursuits that a merchant so often loses all power to enjoy the fruit of his toil, a physician is unknown beyond the sick-room, a surgeon contributes nothing to the cause of science, and a dentist holds no social position. This inevitable tendency of purely practical education was recognized by Lord Brougham when he recommended *Dante* as a text-book, to an inquiring student of law.

The antagonism of trade and pure science is seen not only in the result of attempting to make all education utilitarian. It appears, whenever, in professional life, the laws of barter come to be applied to brain-work and its products. Mercantile relations of cost and price are capable of definite adjustment, when applied to commodities of known values, enhanced by labor at given rates; there are data also upon which the speculative fluctuations of prospective supply and demand are based: so that, in all bargains, buyer and seller may stand upon the ground of equal ability to judge these questions. But professional service is amenable to no such standard: the client cannot estimate the cost of his lawyer's pleading, nor can the patient know, until long afterwards, the full value of his physician's prescription. The conditions of honest barter are absent, for client and patient are alike dependent upon the integrity of the professional man; hence professional bargaining is dishonorable, and inevitably leads to the rendering of a disreputable grade of service. The common practice of valuation by the visit or the hour is so manifestly unequal in its working, that it is only another proof of the impracticability of measuring science and art work by commercial standards.

The medical fee is a valuation of thought and skill, exercised for the preservation of life and health. On the part of the patient, it is considered a gratuity, by those who fail to perceive the elements of cost in such a work; a compensation, by those who recognize an equivalent received; an acknowledgment, by the few who refuse to believe that money can adequately reward such service. Viewed from the professional side, the fee has nothing to do with the quality of the service, nor does it enter into the mind of any right-

thinking man, whilst rendering it. Mr. Ruskin says, with great truth, "it is impossible for a well-educated, intellectual or brave man to make money the chief object of his thoughts; yet a healthy-minded man enjoys the honest winning of money, and will insist upon a fair valuation of his work. But with all brave men, the work is first, and the fee second; whilst there is a vast class, ill educated, cowardly, and more or less stupid, with whom the fee is first and the work second."

All professions have suffered much by this perverted application of mercantile law to professional fees, but none so severely as dentistry. This is due to the prevalent idea that the gold filling and the artificial denture are as legitimate objects of barter and contract as any other tangible article of manufacture; whereas, in reality, they are no more so than the surgical operation, or the medical advice. When the dentist forsakes the vantage ground of a professional fee for "services rendered," and condescends to bargain for the definite products of his skill, he at once destroys the professional character of his position. Not only does he lose caste; but in the class to which he has descended, the question of price invariably leads to considerations of cost, and the quality of his work, slowly, perhaps, but surely, deteriorates. The disastrous influence of vulcanite abundantly proves that, when cost of material is permitted to enter as an element in determining the value of scientific art-work, it inevitably degrades it; and the entire history of prosthetic dentistry shows that competition in price (the development of Mr. Ruskin's "fee first and work second") is fatal to all progress in art or advancement in science. The results of such competition are, to honest men, a life of slavish toil, with no time for self-improvement; to others, a deliberate slighting of work which destroys all the nobility of a man's nature. Dentistry, thus learned and thus practiced, has no just claim to be called a profession; it has neither the liberality, generosity, nor culture, which men are accustomed to associate with professional life; and its pretentious claims serve only to call to mind the satire of Juvenal, "Scire volunt omnes, mercedem solvere nemo."

Dentistry, as a true science and art, is built upon the foundation of a generous early education, is enlightened by a complete medical course of instruction, is specially trained by a full term of practical pupilage, and recognizes no sliding-scale in the quality of the service it renders. Such dentistry will exercise influence in its own, and command respect among kindred professions; for it becomes thus a curative work, second in importance and extent of its usefulness to no specialty of the great Art of Healing.

THE

PRINCIPLES AND PRACTICE

OF

DENTISTRY.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE MOUTH.

THE mouth signifies, in the human subject, the space included between the palatine arch *above*, the mylo-hyoid muscles *beneath*, the lips in *front*, the velum palati *behind*, and the cheeks on *either side*. The teeth and closed jaws separate the inner portion, or lingual cavity, from the outer, or vestibular space; and while that part of the latter bounded by the cheeks ought properly to bear the appellation *buccal*, the term *buccal cavity* is not unfrequently employed with a signification so general as to comprehend the whole oral cavity.

In the mouth are the tongue, teeth, and the alveolar ridges invested by the gums; into it are poured the secretion of the parotid, sub-maxillary and sublingual glands, as well as that of the ordinary mucous and of the special lingual follicles; and in it the food is subjected to the processes of mastication and insalivation previous to deglutition.

It is further concerned in the prehension of aliment; and besides containing the organs of taste, is employed in articulation, expectoration, suction, etc.

The parts concurring to constitute the mouth form a very complicated piece of mechanism; through them it has a wide range of sympathies, and by them it performs a great variety of functions.

The anatomical elements composing these parts consist of Bone, Ligament, Muscle, Gland, Blood-vessel, Nerve, Areolar and Adipose tissues, and Mucous membrane.

These different elements combine together and form the various organs which constitute the mouth.

These organs I shall consider in their physiological order; thus combining their anatomy and physiology, studying at the same time both their healthy structure and function.

CHAPTER II.

OSTEOLOGY.

Bone is one of the hardest substances in the body. It is composed of animal or organic matter in intimate association with earthy, or inorganic matter. From the organic matter the bone derives the properties of toughness and elasticity; and from the earthy material, hardness and solidity. The mineral matter may be dissolved out by a dilute solution of nitric or muriatic acids, while the animal matter remains unaffected, retaining its form, though losing its hardness, so that the long bones, so great is their flexibility, may be tied into a knot; on the other hand, by subjecting them to a high heat in an open fire, while exposed to the air, the animal matter may be consumed, leaving the mineral to preserve the form of the bone, but so insecurely that it will crumble to ashes in the grasp of the hand.

The composition of bone, according to Berzelius, is about one-third animal and two-thirds mineral matter:

Animal Matter,	Gelatin and Blood-vessels,	33.30
Inorganic or Earthy Matter.	Phosphate of Lime,	51.04
	Carbonate of Lime,	11.30
	Fluoride of Calcium,	2.00
	Phosphate of Magnesia,	1.16
	Soda and Chloride of Sodium,	1.20

The proportion of earthy and animal matter is generally thought to vary with varying age. According to Shreger, this difference is as follows:—

	CHILD.	ADULT.	OLD AGE.
Animal Matter,	47.20	20.18	12.2
Earthy Matter,	48.48	74.84	84.1

To this supposed difference has commonly been ascribed the greater brittleness of bones in aged people; but recent analyses tend to show that bone is at all periods of individual life chemically the same, and if so, the inference growing out of the error of former analyses is false.

The development of bone takes place in a manner somewhat different from that of most other tissues, since we have, in addition to the germinal matter and formed material, a deposit of earthy matter in the latter. The formation of the animal matter is a vital phenomenon, the deposit of earthy matter a purely physical one.

The "cell" or "elementary part" of bone consists of a soft central mass of germinal matter, surrounded by a thin layer of soft formed material with which it is continuous, and which "passes uninterruptedly into the hard calcified formed material." This hard formed material is everywhere perforated by little channels called canaliculi, along which the nutrient material is conveyed to the germinal matter. These canaliculi are formed in a manner corresponding to the deposition of the mineral matter, that is, from without inward, commencing at a point most distant from the germinal matter. In the dried bone these canals are seen to communicate with little vacant spaces called lacunæ, occupied in the fresh state with germinal matter, seeming to associate them with one another. In this manner, each lacuna communicates freely with adjacent lacunæ.

The only part of the bone, in Dr. Beale's opinion, which can be said to be living, is the "nucleus" or "bone cell" in the space or lacuna, constituting perhaps one-twelfth part of the bone; all the rest being as dead in the living body as when removed from it. "It (the germinal matter) alone can grow and give rise to the *formation of matrix*. Bone cannot *produce bone*, but the *germinal matter* of bone may become *converted into new bone tissue*." Virchow is of the opinion that the matrix is true intercellular substance into which proceed stellate processes from the cells occupying the lacunæ, thus giving rise to the canaliculi; an opinion directly opposite to that of Dr. Beale, that the canaliculi begin in the matrix (which is not formed independently of the cell, but consists simply of the formed material, or cell wall, in which mineral matter has been deposited), and extend to the germinal matter occupying the lacunal space. This germinal matter is always present in the lacuna; on it depends the circulation of the calcareous matter held in solution by the blood; without it bone tissue cannot be formed, and on its presence the life of the bone depends. The canaliculi, then, are the "altered spaces or ducts which are left between the calcareous globules

originally deposited, and through them pass fluids to and from the germinal matter." (Beale on the Structure and Growth of Tissues, 128.) Originally triangular in form, they finally become so altered by the filling up of the angles as to exhibit a circular appearance on transverse section. The osseous tissue with its canaliculi and germinal matter always bears a fixed and definite relation to the vessels. It may exist as solid cylindrical processes covered with a vascular membrane, or as thin laminæ also covered with a vascular membrane, or as concentric laminæ arranged around a central opening, a "Haversian canal." Each Haversian canal has a diameter of about one-five-hundredth of an inch; though they are of very different sizes, varying from one-fifteen-hundredth to one-two-hundredth of an inch in diameter.

The elementary parts of bone are so arranged as to form either the loose and spongy or cancellated bone tissue, or the more solid and compact or laminated tissue, as in the shaft of a long bone; and between these, in health, a transitional stage may always be observed, while in disease the compact tissue may undergo such modification as to resemble the cancellated. There are also "large spaces like cancelli" in the compact tissue, called the "Haversian spaces," which are merely the canals enlarged by erosion taking place from within outward. The canals and spaces which finally form the fat cells may also undergo conversion into bone tissue, and are originally derived from the same elementary parts as those from which bone is formed.

CHAPTER III.

BONES OF THE HEAD AND FACE.

THE osseous structures in which the student of dentistry is especially interested, and to which we would direct attention, are—

1. The superior maxillary or upper jaw bones.
2. The inferior maxillary or lower jaw bones.
3. The palate bones.

Development of the Bones of the Head and Face.—The first definite form which is developed in the embryo is that of the rudimentary spinal column, its earliest trace being a faint streak, which is known as the *primitive trace* or *groove.* This groove deepens into a furrow, which is bounded by two plates, beneath which a delicate fibril

appears, called the *chorda dorsalis* or *notochord*, in which cartilage is very early developed.

The upper end of the chorda dorsalis terminates in a pointed extremity extending as far forward as the sphenoid bone.

The embryonal cranium is developed from the primitive vertebral disks, which surround the upper extremity of the chorda dorsalis. These disks advance in the form of a membranous capsule, which moulds itself on the cerebral vesicles, so as to constitute the membrane in which the vault of the skull is developed, and which is

FIG. 1.

FACE OF AN EMBRYO OF 25 TO 28 DAYS. (MAGNIFIED 15 TIMES.)

1. Frontal prominence. 2, 3. Right and left olfactory fossæ. 4. Inferior maxillary tubercles, united in the middle line. 5. Superior maxillary tubercles. 6. Mouth or fauces. 7 Second pharyngeal arch. 8. Third. 9. Fourth. 10. Primitive ocular vesicle. 11. Primitive auditory vesicle.

replaced by cartilage in the part corresponding to the base of the skull. A portion of this primitive cartilaginous cranium atrophies and disappears, while another portion remains and forms the cartilages of the nose and the articulations, the basilar part of the occipital, the greater part of the sphenoid, the petrous and mastoid portions of the temporal, the ethmoid, and the septum nasi.

From the anterior end of the chorda dorsalis the four pharyngeal arches proceed on either side and meet in the middle line.

In these pharyngeal arches the secondary bones are developed,

so called to distinguish them from those already referred to, which are formed from the primitive cranium itself. The buccal depression, which afterwards becomes the cavity of the mouth, or rather the fauces, is situated between the first pharyngeal arch and the frontal protuberance.

The first pharyngeal arch divides at its anterior extremity into two parts—a superior and inferior maxillary protuberance, the inferior maxillary uniting very early to the corresponding one of the opposite side, to form the lower jaw.

The superior maxillary protuberances are united to the external nasal process, and the palate bone, the superior maxillary, the malar, and also the internal plate of the pterygoid process, are developed from this process. From the internal nasal process, the nasal bones, the lateral portions of the ethmoid, and the os unguis are developed. From the incisive tubercle or process, which unites the rest of these processes on either side, and which grows downward from the frontal prominence, filling in the space between the extremities of the two processes which proceed from the first pharyngeal arch, the intermaxillary bone; the middle of the upper lip, and the vomer, are formed. When the middle and two lateral processes fail to unite, the deformity known as *hare-lip* is caused. From the lateral processes of the superior maxilla the plates which form the hard palate grow toward each other, union occurring in the median line. This union of the plates separates the nose from the buccal cavity, and is generally completed at the end of the second month. Prior to this union of the plates by their complete development, the nose and buccal cavity form but one cavity; and when this union does not take place the deformity known as *cleft-palate* results. Cleft-palate often accompanies hare-lip, as the causes which produce the latter deformity, during the development of the intermaxillary bones, may prevent the natural development of the palate bones.

At an early period of embryonal life the inferior maxillary arch, which also arises from the first pharyngeal arch, is altogether destitute of any trace of osseous tissue, but it encloses within the elements composing it a symmetrical cartilaginous band, which performs a transitory part only in the development of the jaw.

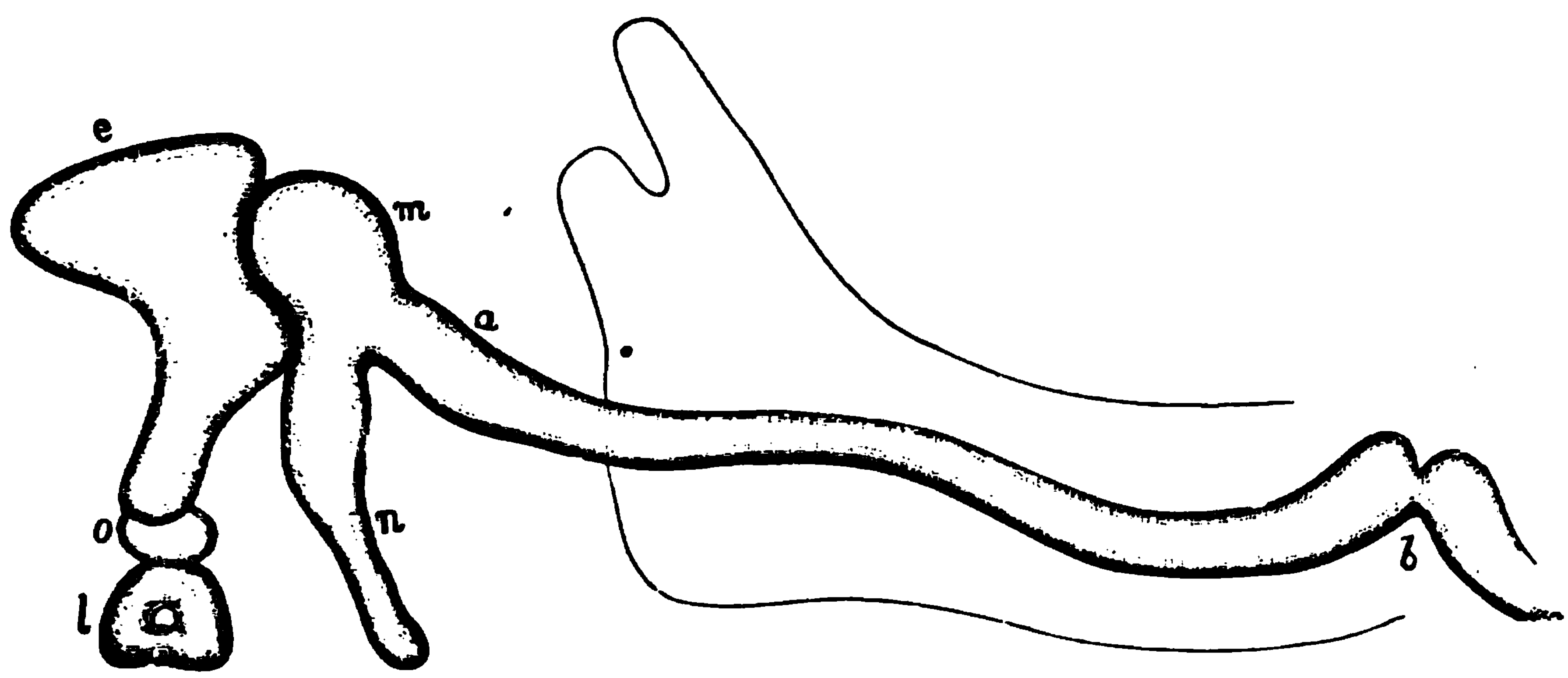
This band is called "Meckel's Cartilage," and it occupies the interior of the maxillary arch, having the form of a whitish cord situated in a bed of soft transparent tissue, and is composed of two symmetrical parts corresponding to the right and left sides of the lower jaw, which parts soon become united at the mental symphysis. From this point of juncture the two halves extend on either

side to the bones of the ear, terminating in the malleus, which, with the incus, is formed from it.

Meckel's cartilage gives form and stability to the lower jaw of the embryo, and is the first solid structure discovered in the maxillary arch. It first appears about the twenty-fifth day, and during its existence, which extends to the fifth month of fœtal life, it is subject to constant modifications or transitory states.

As soon as the cartilage has attained its full development, a period which corresponds to the ossification of the malleus, it begins to disappear, except the end which extends up to the tympanum and

Fig. 2.



MECKEL'S CARTILAGE, FROM EMBRYO OF 40 TO 42 DAYS, BEFORE APPEARANCE OF MAXILLARY BONE.

a, Enlargement of cartilage near neck of malleus; *b*, a slightly enlarged portion of cartilage, but contracted at median line, where it unites with that of opposite side; *n*, handle of malleus; *o*, cartilage of the os lenticulare; *l*, cartilage of the stapes; *s*, outline of the jaw to be formed.

becomes ossified into the malleus, owing to the action of the osteoblasts by which this cartilage is ossified, and becomes a part of the maxilla.

In the upper jaw the period of evolution corresponds with that of the lower jaw; Meckel's cartilage belongs exclusively to the lower jaw.

Fig. 3.

FROM HUMAN EMBRYO OF SIXTY DAYS, NATURAL SIZE.

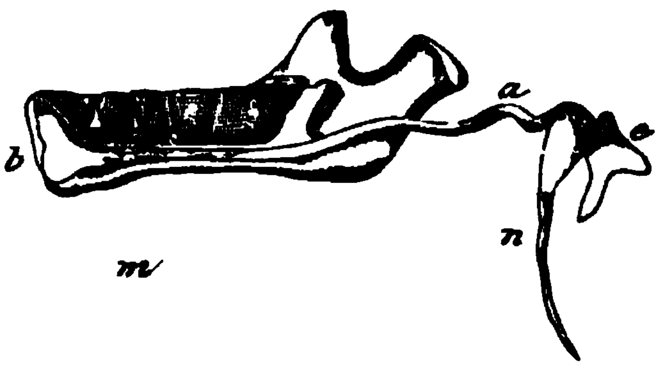
A, Extra-tympanic portion of Meckel's cartilage; B, symphysis; H, handle of malleus.

At a period between the thirty-fifth and fortieth days of embryonal life, slight traces of ossification are observed at points midway

between the angle and symphysis of the future jaw, and the ossification extends rapidly in both directions, anterior and posterior, along the external face of Meckel's cartilage, and in contact but not united with it.

At about the second month of gestation, the rudimentary jaw bone is formed, but not completed; it is composed of two arches, an internal cartilaginous one, composed of Meckel's cartilage; and an external one, composed of osseous matter; the former being only needed for a time, to support the jaw, and the latter the rudiment of the bone of the jaw.

Fig. 4.



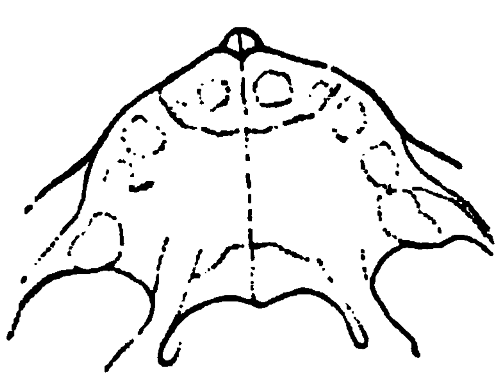
INTERNAL FACE OF RIGHT INFERIOR MAXILLA OF EMBRYO OF THREE MONTHS.

a, Extra-tympanic portion; *b*, symphysis of the cartilage; *n*, handle of malleus; *e*, cartilage of incus.

While later in life there are two superior maxillary bones, in early fœtal life there exists what are called inter-maxillary bones, the upper jaw during its development being composed of four bones—two maxillary and two inter-maxillary. In each of the two inter-maxillary bones are developed two incisors—a central and a lateral, and in each of the two maxillary bones—a canine and two molars—later a canine, two bicuspids and three molars. Before birth the inter-maxillary and the maxillary bones unite, reducing the number to two instead of four, and the inter-maxillary suture, where the union takes place, can be seen at birth on the palatal surface but not on the outer surface.

These inter-maxillary bones are designated by Huxley as *premaxillæ*, and in some animals they remain permanently as separate bones.

Fig. 5.



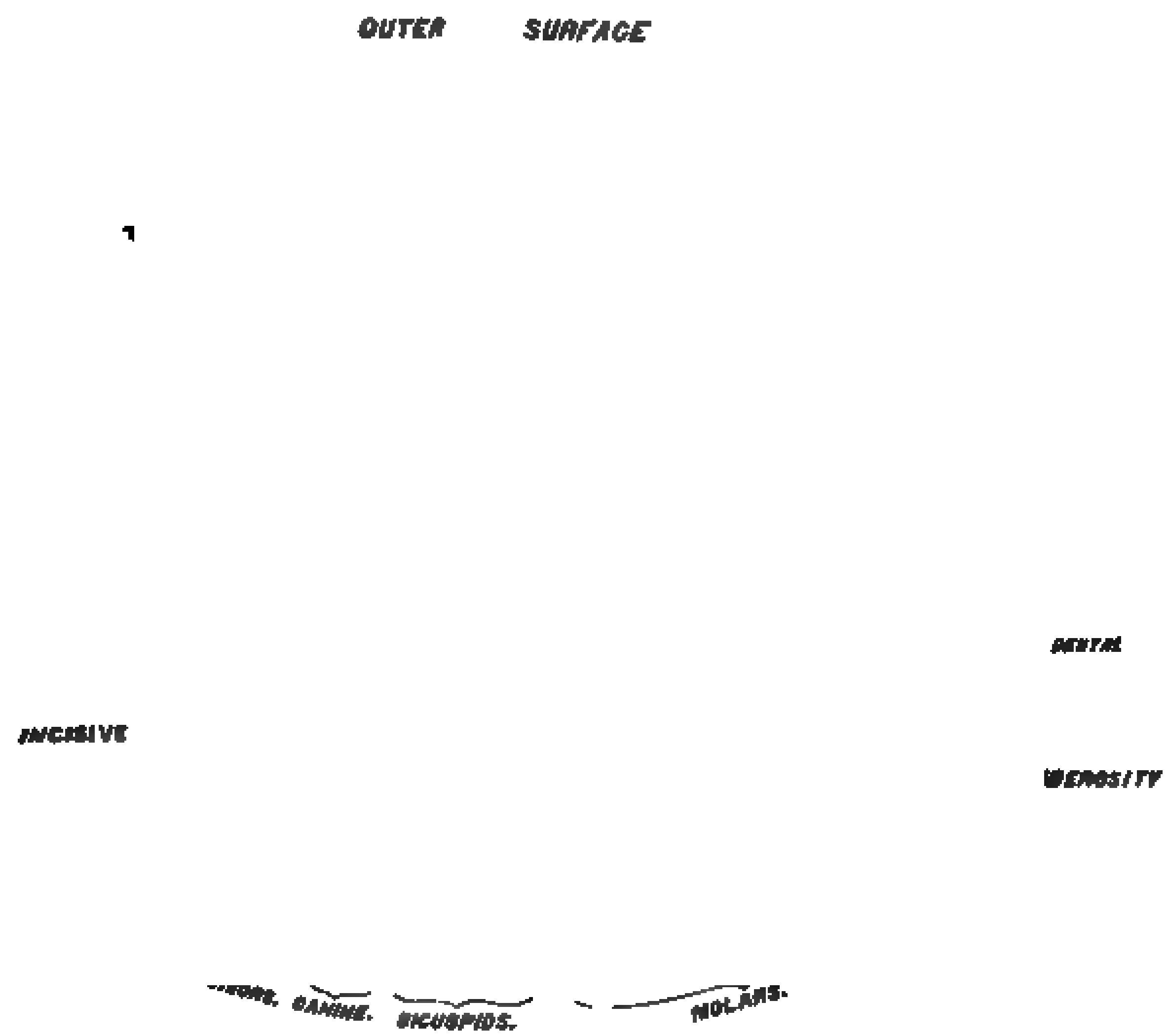
FROM FŒTUS OF FOUR MONTHS, SHOWING INTER-MAXILLARY SUTURE ON PALATAL SURFACE, WHERE THE INTER-MAXILLARY BONES HAVE UNITED WITH THE MAXILLARY BONES.

The buccal cavity comprises the mouth and nose until a lamina is formed from the superior maxillary tuberosity on either side which has a horizontal inward direction. The two palatine lamellæ meet in the median line, in front, about the eighth week, and the septum is completed about the ninth week. The superior maxillary bones and the soft parts covering them unite at an early period with the inter-maxillary or incisive bone, and the median portion of the lower lip. The nostrils are formed by the olfactory fossæ opening into the upper or respiratory portion of the cavity.

THE SUPERIOR MAXILLARY BONES.

The *Superior Maxillary Bones*, two in number, are in pairs, and united on the median line of the face. They occupy the anterior upper part of the face, are of very irregular form, and consist of a body and processes. They are the largest bones of the face except the inferior maxilla, and enter into the formation of three cavities, the orbit, the mouth and the nares; they also enter into the forma-

Fig. 6.



tion of the zygomatic and spheno-maxillary fossæ, and the spheno-maxillary and pterygo-maxillary fissures.

The body is the central part of the bone, and has four surfaces; namely, the external or facial, the posterior or zygomatic, the superior or orbital, and the internal or palatine.

The *External Surface* is irregularly convex, and has a depression about its centre, just above the canine and first bicuspid teeth, called the canine fossa; immediately above which is the infra-orbital

foramen for transmitting an artery and nerve of the same name; its upper and inner edge forms part of the lower margin of the orbit, to which is attached the levator labii superioris proprius muscle.

The *Posterior Surface* has a bulging, called tuberosity, which is connected with the palate bones, and bounds the antrum behind; it is perforated by three or four small holes—the posterior dental canals, which transmit nerves and blood-vessels to the molar teeth. This surface presents also on its nasal face a groove, which becomes, by articulation with the palate bone, the posterior palatine canal.

Fig. 7.

The *Internal Surface* extends from the alveolar processes in front to the horizontal plate of the palate bones behind, called the palatine processes, which are rough below, forming the roof of the mouth, and smooth above, making the floor of the nostrils. They are united along the median line, at the anterior part of which is the foramen incisivum, having two openings in the nares above, while there is but one in the mouth below. The body of the superior maxilla is occupied by a large and very important cavity called the *Antrum Highmorianum*, or Maxillary Sinus. This cavity is somewhat triangular in shape, with its base generally looking to

the nose, and its apex to the malar process. Its upper wall is formed by the floor of the orbit, its lower by the alveoli of the molar teeth, which sometimes perforate this cavity. The canine fossa bounds it in front, while the tuberosity closes it behind. But the shape of this cavity is exceedingly variable. In examining a collection of nearly one hundred maxillæ in the Dental Department of the University of Maryland, no two sinuses were found to be shaped alike; and this difference is as marked between the right and the left in the same, as in different subjects. The floor of some is nearly flat, but in the majority of cases it is very uneven; sometimes crossed by a single septum, varying from one-eighth to half an inch in height; at other times there are found three or four septa, dividing the lower part of the cavity into as many separate compartments, with the bottom or floor of no two on a level with each other. Some are perforated by the roots of one or more teeth; at other times the roots of several teeth extend considerably above the level of the floor of the antrum, covered by a lamina of bone scarcely thicker than bank-note paper. In other cases, the floor of the antrum is half an inch above the extremities of the roots of the teeth. This cavity also varies as much in size as it does in shape.

The opening of the antrum is, on its nasal portion or base, into the middle meatus of the nose; in the skeleton it is large, while in the natural state it is much contracted by the ethmoid bone above, the inferior turbinated bone below, the palate bone behind, and by the mucous membrane which passes through the opening and lines the interior of the antrum. A deep groove lies in front of the opening in the antrum, which is converted into a canal for the nasal duct by the lachrymal and inferior turbinated bones.

The *Malar Process* is a rough, triangular process, marking the boundary between the external and internal surfaces. It presents on its upper margin a roughened surface for articulation with the malar bone.

The *Nasal Process* forms the lateral boundary of the nose. It is a thick, triangular prominence articulating at its upper extremity, by a serrated edge, with the frontal bone, and, by an uneven surface, with the ethmoid bone; a little lower on its internal surface it offers a transverse ridge, the superior turbinated crest, for articulation with the middle turbinated bone; below this is the inferior turbinated crest, to which is attached the inferior turbinated bone; and lying between these crests is a smooth, concave space, forming part of the middle meatus, while beneath the inferior crest is a like space which forms part of the inferior meatus. By its anterior

border it is articulated with the nasal bone, and by its posterior with the lachrymal bone, forming with it the canal for the nasal duct, while at the junction of the anterior lip of the nasal groove with the orbital surface is placed the lachrymal tubercle, serving as a guide to the duct in all operations for fistula lachrymalis.

The *Alveolar Process* is formed on the lower edge of the external surface; it is broader behind than in front, and is perforated with excavations corresponding in number with the teeth; those depressions which receive the teeth of more than one fang are subdivided by bony septa into compartments of a sufficient number to receive these fangs.

The bottom of each of these cavities is perforated by a small foramen, for the passage of nerves and blood-vessels which supply the teeth. The alveolar border externally presents a fluted appearance; the projections correspond with the alveolar cavities, and the depressions with the septa which divide them from one another.

Fig. 8.

The *Palate Process* forms the roof of the mouth and part of the floor of the nose; it is thick and strong, and presents in front the orifice of the anterior palatine canal through which passes the anterior palatine vessels, whilst the inferior naso-palatine nerves pass along the inter-maxillary suture. The inferior surface at the back part has a deep groove, sometimes a canal, for the passage of the posterior palatine vessels, and a nerve of large size; it is also perforated with numerous foramina for the passage of nutrient vessels. The outer border is closely attached to the rest of the bone. The inner border, thicker in front than behind, presents a ridge, which, together with a similar ridge on the opposite bone, forms a groove in which the vomer is received. The anterior margin is prolonged into a sharp process, the nasal spine. By its posterior border it articulates with the horizontal plate of the palate bone.

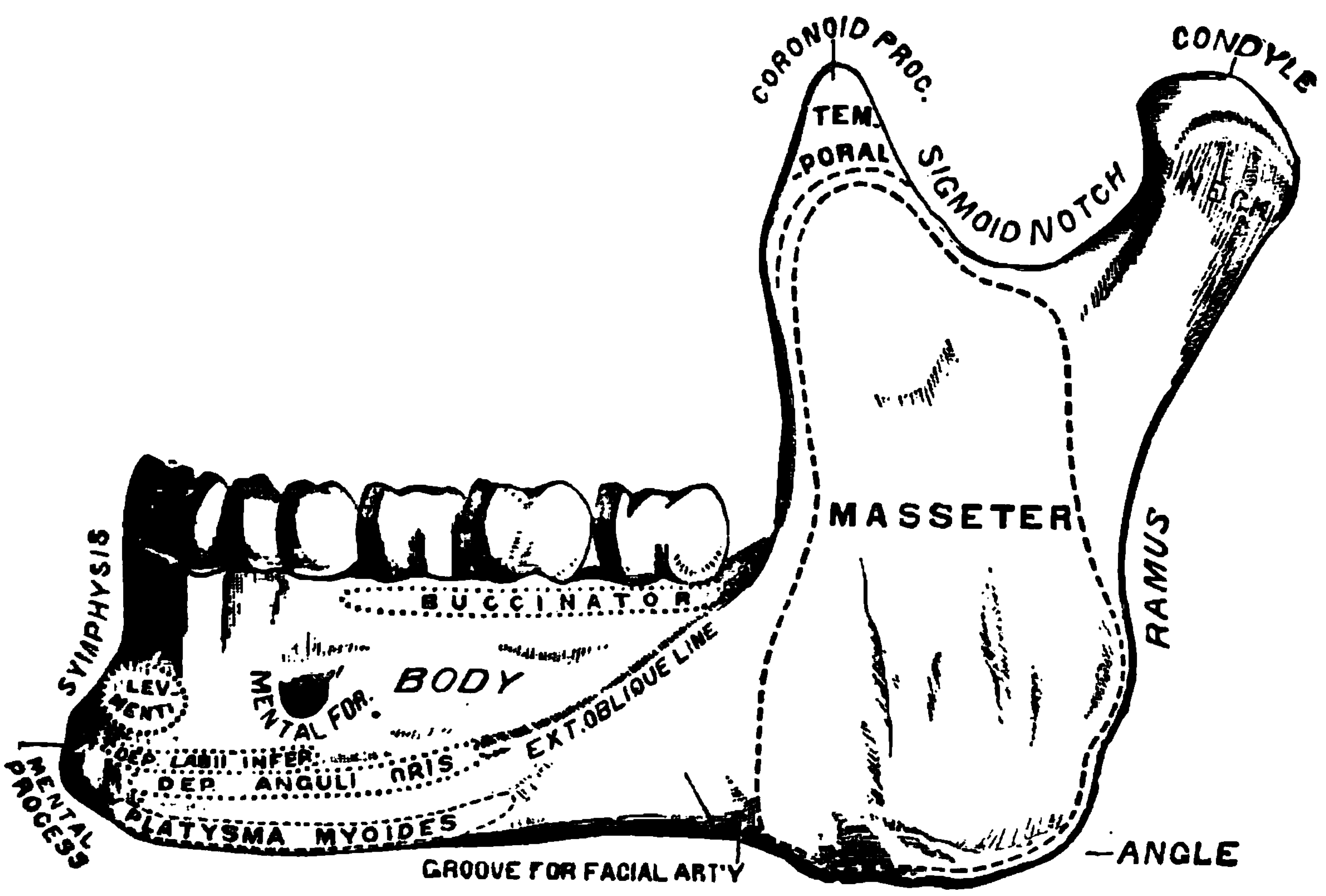
The structure of the upper jaw, with its alveolar and numerous other processes, is thick and cellular; the cancellated structure being invested with a thin layer of compact bone.

It is articulated with two bones of the cranium, the frontal and ethmoid, and seven of the face, namely: the nasal, malar, lachry-

mal, palate, inferior turbinated, vomer, and to its fellow, by sutures; also to the teeth by the articulation termed *gomphosis.*

Its development commences at so early a period of intra-uterine life, and ossification proceeds so rapidly, that the nunber of ossific centres is uncertain; some give a centre for the body and each process, others think that most probably there are but four centres in all. It may be seen as early as the thirty-fifth or fortieth day after conception; and although at birth it has acquired but little height, it has increased considerably in breadth. But at this period the alveolar border, which constitutes the largest portion of the bone, is almost in contact with the orbit. The antrum is still scarcely perceptible, but as the vertical dimensions of the bone are increased,

FIG. 9.



it is gradually developed. With the loss of the teeth, the alveolar border nearly disappears, so that the vault of the palate loses its arched form, and sometimes becomes almost flat.

The *Upper* or *Orbital Surface* is triangular in shape, with its base in front forming the anterior, lower and internal edges of the orbit, while its apex extends back to the bottom, forming the floor of the orbit and roof of the antrum; its internal edge is united to the lachrymal, ethmoid and palate bones; its external edge assists in forming the spheno-maxillary fissure, and along its central surface is seen a canal running from behind, forward and inward—the

infra-orbital canal. This canal divides into two; the smaller is the *anterior dental*, which descends to the anterior alveoli along the front wall of the antrum; the other is the proper continuation of the canal, and ends at the infra-orbital foramen.

THE INFERIOR MAXILLARY BONE.

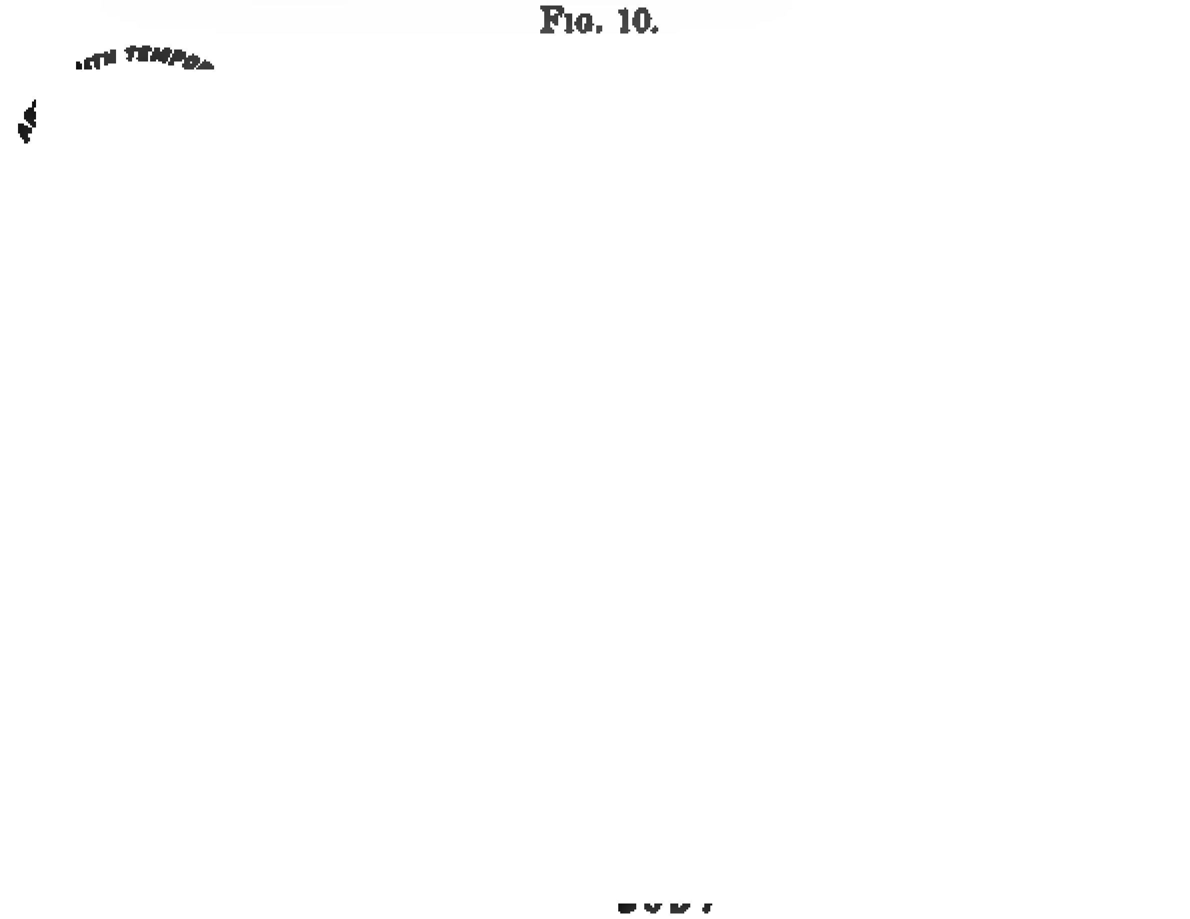
The *Inferior Maxillary Bone* (Fig. 9) is the largest bone of the face, and though single in the adult, it consists of two symmetrical pieces in the fœtus.

It occupies the lower part of the face, has a parabolic form, and extends backward to the base of the skull.

It is divided into a body and extremities.

The body is the middle and horizontal portion; this is divided along its centre by a ridge called the *symphysis*, which is the place

FIG. 10.



of separation in the infant state; the middle portion projects at its inferior part into an eminence called the *mental process* or chin; on each side of which is a depression for the muscles of the lower lip; and externally to these depressions are two foramina, called *anterior mental*, for transmitting an artery and nerve of the same name.

The horizontal portions extend backward and outward, and on

the outward surface have an oblique line for the attachment of muscles.

On the inner surface of the middle part, behind the chin, along the line of the symphysis, there is a chain of eminences called *genial tubercles*, to the superior of which the frænum linguæ is attached, to the middle the genio-hyo-glossi, and to the inferior the genio-hyoid muscles; on each side of these eminences are depressions for the sublingual glands; and beyond these depressions there runs an oblique ridge upward and outward, to the anterior part of which is attached the mylo-hyoid muscle, and to the posterior part, the superior constrictor of the pharynx; this latter muscle is consequently involved more or less in the extraction of the last molar tooth. Below this line there is a groove for the mylo-hyoid nerve, and a depression, the submaxillary fossa, for the reception of the submaxillary gland.

The alveolar border, in the fœtus, constitutes nearly the whole body of the bone. After the loss of the teeth, this part of the inferior maxillary is gradually wasted. The alveolar border in the lower jaw describes a rather smaller arch than it does in the upper, and both its anterior walls are thinner than the posterior. Passing over the inferior border, near the junction of the body with the ramus, is a groove for the facial artery.

The extremities of the body have two large processes rising up to an obtuse angle, named the *rami* of the lower jaw. These processes are flat and broad on their surfaces; the outer one is covered by the masseter muscle; the inner one has a deep groove which leads to a large hole, the *posterior dental* or maxillary foramen, for transmitting the inferior dental nerves and vessels to the dental canal running along the roots of the teeth. This foramen is protected by a spine to which the spheno-maxillary ligament is attached.

The ramus has a projection at its lower part, which is the angle of the lower jaw; its upper ridge is curved, having a process at each end—the anterior one is the *coronoid process;* this is triangular, and has the temporal muscle inserted into it; the posterior is the *condyloid*, and articulates with the temporal bone. This process has a neck which receives the insertion of the external pterygoid muscle.

The *Coronoid Process* is thin, flat, and triangular. To its external surface is attached the temporal and masseter muscles. On its internal surface is a long latitudinal ridge extending to the posterior part of the alveolar process, and to which is attached the temporal

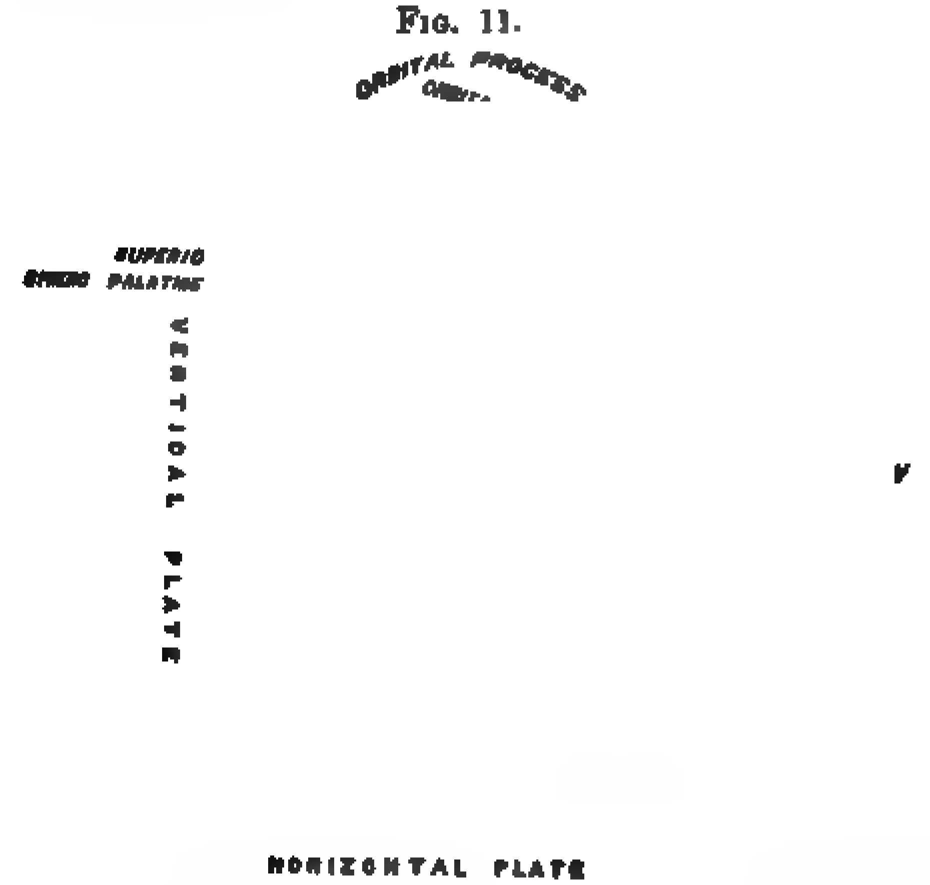
muscle above and the buccinator muscle below. In front of this ridge is a deep groove, to which the temporal and buccinator muscles are in part attached.

The *Condyloid Process* consists of two portions—a condyle and a neck. The condyle is of an oval form, convex both laterally and from before backward. The neck of the condyle, flattened from before backward, convex on its posterior surface, presents anteriorly a depression, the pterygoid fossa, for the attachment of the external pterygoid muscle. Between these two processes is the sigmoid notch, a semilunar depression over which passes the masseteric artery and nerve.

The structure of the inferior maxilla is compact externally, cellular within, and is traversed the greater part of its extent by the inferior dental canal.

The lower jaw is developed from two centres of ossification, which meet at the symphysis. It articulates on each side, by one of its

FIG. 11.



condyles, with the glenoid cavity of the temporal bone, situated at the base of the zygomatic process. This cavity is divided into two portions—an anterior and a posterior. The former constitutes the articular portion, the latter lodges a process of the parotid gland. The two are separated by the fissure of Glasserius, which transmits the chorda tympani nerve, the laxator tympani muscle, and the anterior

tympanic artery. It also gives lodgment to the long process, *processus gracilis*, of the malleus.

Between this cavity and the condyle there is interposed an inter-articular cartilage, so moulded as to fit the two articular surfaces. The circumference of this being free, except where it adheres to the external lateral ligament, affords attachment to a few fibres of the external pterygoid muscle, and facilitates the movements of the joint.

The union of this articulation is maintained by the external lateral, the spheno-maxillary, and the stylo-maxillary ligaments.

THE PALATE BONES.

The *Palate Bones*, two in number, are situated at the back part of the superior maxillary bone, between its tuberosities and the pterygoid processes of the sphenoid bone.

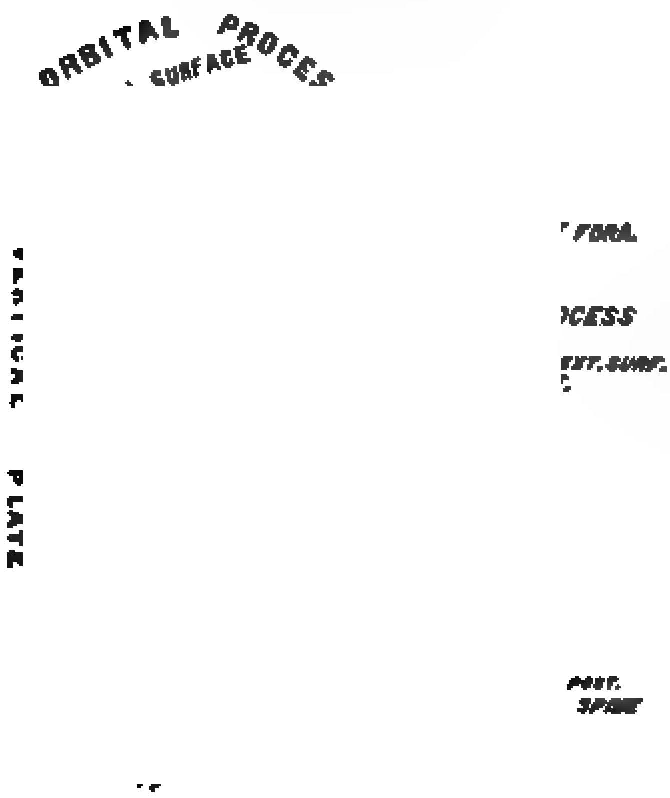
The palate bone is divided into two plates: the inferior or horizontal, and the superior or vertical.

The *horizontal plate* is broad and on the same line with the palate processes of the superior maxillary bone; its upper surface is smooth and forms the posterior floor of the nostrils; the lower surface is rough and forms the posterior part of the roof of the mouth; its anterior edge is connected with the palate processes of the upper jaw, and its posterior is thin and crescentic, to which is attached the velum-pendulum palati, or soft palate; at the posterior point of the suture, uniting the two palate bones, there projects backward a process called the *posterior nasal spine*, which gives origin to the azygos-uvulæ muscle. The *vertical plate* ascends, helps to bound the nasal cavity, diminishes the opening into the antrum by projecting forward, and by its external posterior part, in conjunction with the pterygoid processes of the sphenoid bone, forms the *posterior palatine canal;* the lower orifice of which is seen on the margin of the palate plate, and is called the *posterior palatine foramen*, transmitting the palatine nerve and artery to the soft palate; behind this foramen is often seen a smaller one, passing through the base of the pterygoid process of this bone, and sending a filament of the same nerve to the palate.

The upper end of the vertical or nasal plate has two processes—the one is seen at the back of the orbit, called the *orbital* process; the other is posterior, and fits against the under surface of the body of the sphenoid bone. Between these two processes is a foramen, the *spheno-palatine*, which transmits to the nose a nerve and artery of the same name.

The palate bone articulates with six others, namely: the superior maxillary, inferior turbinated, vomer, sphenoid, ethmoid and opposite palate.

Fig. 12.



The structure of this bone is very thin, and consists almost entirely of compact tissue. Its development, it is said, takes place by a single point of ossification at the union of the vertical, horizontal and pyramidal portions.

The bones of the head are twenty-two in number, of which eight compose the cranium and fourteen the face. Those of the cranium are one frontal, two parietal, two temporal, one occipital, one sphenoid and one ethmoid. Those of the face are six pairs and two single bones; the pairs are the two malar, two superior maxillary, two lachrymal, two nasal, two palatine and two inferior turbinated. The vomer and inferior maxillary are the two single bones.

CHAPTER IV.

MUSCLES.

Muscles are the fleshy parts of the body. They are the active organs of locomotion, and are composed of fibres bound together in bundles, or fasciculi, by delicate areolar tissue.

The muscular fibres of which each muscle is compounded are called ultimate fibres. Of these anatomists recognize two kinds—voluntary or animal fibres (striped), and involuntary or organic fibres (unstriped). The former are generally under the influence of the will, are of uniform size, and present transverse markings. They compose the muscles of the trunk and limbs, as well as those of the heart, urethra, internal ear, and, in part, those of the œsophagus; though the muscles of the heart are striped, they are not voluntary; the muscular coat of the urethra consists of two layers of plain, muscular fibre; the muscles of the internal ear are striped,

but are not voluntary; in the upper part of the œsophagus the muscular fibres consist chiefly of the striped variety, but below they consist entirely of the involuntary or unstriped muscular fibre.

The involuntary fibres are not under volitional control, are not striped, are of smaller size and homogeneous structure. They are found in the digestive canal, uterus and bladder. The voluntary muscles terminate in fibrous tissue, which is sometimes gathered together in bundles to form tendon, or is spread out in a membranous form, and is then called aponeurosis. By one or the other of these terminal forms almost all muscles are attached to those parts which it is their office to move.

The involuntary muscles are generally found interlacing freely around a cavity, which, by their contraction, they constrict, expelling its contents. Each muscle is closely though loosely invested by a sheath of cellular tissue, which also sends prolongations into the body of the muscle, investing each fibre and binding them together. The muscles of expression, which are especially interesting in their relation to prosthetic dentistry, are quite numerous, and are very closely connected with the subcutaneous tissue and the skin. Muscles are variously named, according to their form, long, broad, short, etc. These names sufficiently explain themselves. Other names are given them, depending on the arrangement of their fibres, their situation, number of divisions, office, etc. The muscles of the mouth, for example, are named elevators, depressors, sphincters, etc., according to their respective functions. For fuller explanation, students are referred to more exclusively anatomical works.

The *Fascia*, which everywhere invests the more delicate organs, is of two kinds—superficial or fibro-areolar, and deep or aponeurotic. The superficial fascia lies just beneath the skin, and covers nearly the entire surface of the body. It serves to connect the skin with the deep fascia, and furnishes a nidus for nerves and blood-vessels passing to the skin.

The deep fascia is composed of fibres arranged in a reticulated manner, forming a dense, inelastic membrane, which invests each muscle in a separate sheath. Sheaths are also formed from it for the vessels and nerves; and it serves also as points of attachment for the muscles.

Each striped muscular fibre is composed of two parts—a proper substance called the sarcous element, in which the contractile property resides, and a sheath or sarcolemma, a transparent, structureless membrane, in which is contained the contractile substance. These elementary fibres are connected by areolar tissue, with which a little fat is often associated. Lying between these fibres are blood-vessels, nerves and lymphatics.

The sarcous element is a soft, granular material, on the varying relations of which granules to each other depend the alterations in appearance of the striæ. If they approach each other more closely in the direction of the length of the fibre than in its width, it will appear fibrillated; if the reverse, it will present the appearance of discs.

Muscles, like all other tissues, are developed from germinal matter which has undergone special metamorphosis, under the impulse of the parent cell, to construct this tissue. "Germinal matter" and "formed material" constitute the "elementary part," according to Mr. Beale, or the muscular cell, of the other writers, from which the muscular fibre is formed. In the formed material, which is the constructed muscle, resides the power of contraction. The germinal matter or constructive part does not possess this property.

Following the arrangement of Mr. Gray, we shall divide the muscles which it is our purpose to describe into certain groups, as follows:

1. NASAL GROUP.

Pyramidalis Nasi.
Levator Labii Superioris Alæque Nasi.
Levator Proprius Alæ Nasi Posterior.
Levator Proprius Alæ Nasi Anterior.
Compressor Naris.
Compressor Narium Minor.
Depressor Alæ Nasi.

2. SUPERIOR MAXILLARY GROUP.

Levator Labii Superioris Proprius.
Levator Anguli Oris.
Zygomaticus Major.
Zygomaticus Minor.

3. INFERIOR MAXILLARY GROUP.

Levator Labii Inferioris.
Depressor Labii Inferioris.
Depressor Anguli Oris.
Platysma Myoides.

ADJUNCT GROUP.

Musculus Risorius.
Orbicularis Oris.
Buccinator.

4. TEMPORO-MAXILLARY GROUP.

Masseter.
Temporal.

5. PTERYGO-MAXILLARY GROUP.

Pterygoideus Externus.
Pterygoideus Internus.

6. LINGUAL GROUP.

Genio-hyo-glossus.
Hyo-glossus.
Lingualis.
Stylo-glossus.
Palato-glossus.

7. PHARYNGEAL GROUP.

Constrictor Inferior.
Constrictor Medius.
Constrictor Superior.
Stylo-pharyngeus.
Palato-pharyngeus.

8. PALATAL GROUP.

Levator Palati.
Tensor Palati.
Azygos Uvulæ.
Palato-glossus.
Palato-pharyngeus.

1. Nasal Group.

Pyramidalis Nasi.
Levator Labii Superioris Alæque Nasi.
Levator Proprius Alæ Nasi Posterior.
Levator Proprius Alæ Nasi Anterior.
Compressor Naris.
Compressor Narium Minor.
Depressor Alæ Nasi.

The *Pyramidalis Nasi* is a triangular, muscular slip extended from the occipito frontalis. It lies along the side of the nose, and blends by a tendinous expansion with the compressor naris.

The *Levator Labii Superioris Alæque Nasi* is also a triangular muscle, arising from the nasal process of the superior maxilla, its upper part. Passing down behind the muscle just described, it divides into two muscular slips, one of which is inserted into the cartilage of the ala of the nose, the other is continued to the angle of the mouth, where it blends with the orbicularis oris and levator labii proprius.

Beneath this muscle is a small muscular slip extending from the origin of the compressor naris to the nasal process, about an inch above it. It is called the "Musculus Anomalus," or the "Rhomboideus."

The *Levator Proprius Alæ Nasi Posterior*, or Dilator Naris Posterior, extends from the nasal notch to the margin of the nostril.

The *Levator Proprius Alæ Nasi Anterior*, or the Dilator Naris Anterior, is situated a little in front of the last described muscle, and arises from the cartilage of the wing of the nose, and is inserted into the integument near its margin.

The *Compressor Naris*, triangular in form, arises from the superior maxilla, a little above and external to the incisive fossa, and is attached to the fibro-cartilage of the nose, joining at the median line with its fellow of the opposite side.

The *Compressor Narium Minor* extends from the alar cartilage to the integument of the end of the nose.

The *Depressor Alæ Nasi* arises from the incisive fossa of the superior maxilla, and, dividing into two sets of fibres, ascending and descending, is inserted into the septum and posterior portion of nasal cartilage, and by some fibres of the latter into the back part of the orbicularis oris.

The facial nerve supplies all the muscles of this group.

Their respective actions are sufficiently explained by their names, except the pyramidalis, which draws down the inner angle of the eyebrow, and perhaps aids in dilating the nostril, and the com-

pressores nasi, whose action is directly opposite to that implied by their names.

The contraction of the levator labii superioris alæque nasi gives to the face the expression of contempt.

2. Superior Maxillary Group.

Levator Labii Superioris Proprius.
Levator Anguli Oris.
Zygomaticus Major.
Zygomaticus Minor.

The *Levator Labii Superioris Proprius* arises from the lower margin of the orbit, some of its fibres from the superior maxillary, others from the malar bone; they pass down to be inserted in the fleshy part of the upper lip.

The *Levator Anguli Oris* arises from the canine fossa, just below the infra-orbital foramen, and descends to the angle of the mouth, where it blends with the orbicularis oris, the zygomatici and the depressor anguli oris muscles.

The *Zygomaticus Major* is a delicate fasciculus, arising from the malar bone, and finding attachment to the orbicularis and depressor anguli oris at the angle of the mouth.

The *Zygomaticus Minor* arises from the malar bone, just behind the maxillary suture, and passes downward and inward, to be inserted in the outer margin of the levator labii superioris, with which it is continuous.

These muscles are also supplied by the facial nerve.

The action of the levator muscles is described in their names. The zygomatici draw the lip upward and outward, as in laughing.

3. Inferior Maxillary Group.

Levator Labii Inferioris.	(Levator Menti.)
Depressor Labii Inferioris.	(Quadratus Menti.)
Depressor Anguli Oris.	(Triangularis Menti.)

Platysma Myoides.

The *Levator Labii Inferioris* arises from the incisive fossa just external to the symphysis of the chin; it is a small, conoidal fasciculus, and is inserted into the integument of the chin.

The *Depressor Labii Inferioris* is a quadrilateral muscle, arising from the oblique line of the inferior maxilla, between the incisive fossa and mental foramen, and is attached to the integument of the lower lip, blending with the orbicularis oris and with its fellow of the opposite side.

The *Depressor Anguli Oris*, situated externally to the last-men-

tioned muscle, also arises from the external oblique line of the lower jaw, and is attached at the angle of the mouth to the orbicularis, levator anguli and zygomaticus major muscles.

The facial nerve supplies this group.

Their action is indicated by their names.

The *Platysma Myoides* arises from the subcutaneous tissue over the pectoralis major, trapezius and deltoid muscles, and passes obliquely over the clavicle and the side of the neck, its fibres terminating in the skin of the chin, the subcutaneous tissue of the cheek, the muscles at the corner of the mouth, the middle fibres being attached along the base of the jaw. It forms a defence for the neck, and is a muscle of expression from its functions of moving the skin, belonging to the class known as cutaneous muscles.

The Musculus Risorius, Orbicularis Oris and Buccinator form a group closely connected with the superior and inferior maxillary groups.

The *Musculus Risorius* is considered by many as a part of the platysma myoides, the large subcutaneous muscle of the neck. It arises from the fascia over the masseter muscle, and, after passing horizontally forward, is inserted into the angle of the mouth, where it joins the orbicularis oris and depressor anguli oris. It gives the smile of derision.

The *Orbicularis Oris* surrounds the mouth, and forms a centre from which muscles diverge and are fixed into the surrounding bones. It is the antagonist of all the muscles which move the lips, and has no bony origin or insertion. It is nearly an inch in breadth, and the prominence of the lips depends upon its size and thickness.

The *Buccinator* arises from the outer surface of the alveolar borders of the superior and inferior maxillæ, corresponding to the molar teeth, and its fibres pass forward and are inserted into the angle of the mouth and the muscular structure of the lips. The buccinator is the principal muscle of the cheek, and, with the superior constrictor of the pharynx, forms a muscular wall for the sides of the mouth and pharynx. It is pierced by the duct of the parotid gland, which opens into the mouth opposite the superior second molar tooth. The functions of the buccinator are to expel air from the mouth by inflating the cheek, to widen the mouth, and to keep the food between the teeth during mastication. The facial nerve supplies this muscle, which is affected in facial paralysis. The buccinator muscle is covered by a thin layer of fascia known as the buccal fascia, which adheres closely to its surface and is attached to the alveolar border of the superior and inferior

maxillæ. The density of this fascia prevents abscesses from readily discharging into the mouth or the pharynx.

4. Temporo-Maxillary Group.

Temporal.
Masseter.

The *Temporal Muscle* (Fig. 13) is seen on the side of the head. It has its origin from the semicircular ridge, commencing at the external angular process of the os-frontis, and extending along this

FIG. 13.

and the parietal bone; also from the surfaces below this ridge formed by the frontal and squamous portion of the temporal and sphenoid bones; likewise from the under surface of the temporal aponeurosis, and from a fascia covering this muscle; and its fibres are inserted, after they have converged and passed under the zygoma, into the coronoid process of the lower jaw, surrounding it on every side by a dense, strong tendon.

The *Masseter Muscle* (Fig. 14) is seen at the side and back part of the face, in front of the meatus externus, and lies directly under the skin. It arises by two portions: the one, anterior and tendinous, from the superior maxilla where it joins the malar bone; the other portion, mostly fleshy, from the inferior edge of the malar bone and

the zygomatic arch as far back as the glenoid cavity, and is inserted, tendinous and fleshy, into the external side of the ramus of the jaw and its angle as far up as the coronoid process.

The inferior maxillary nerve supplies both these muscles.

The office of the temporal muscle is to bring the two jaws together, as in the cutting and rending of the food.

Fig. 14.

The use of the masseter muscle, when both portions act together, is to close the jaws; if the anterior acts alone, the jaw is brought forward; if the posterior, it is drawn backward.

The use of the pterygoid muscle is to aid the temporal and masseter muscles in the trituration of the food. The external pterygoids

carry the lower jaw directly forward when acting together; to one or the other side when acting separately. The internal pterygoid aids the masseter and temporal in bringing the lower jaw firmly up against the superior maxilla, and also assists in carrying the lower jaw forward.

The inferior maxillary nerve supplies these muscles, which form the pterygo-maxillary group, and which come next in order of description.

5. Pterygo-Maxillary Group.

Pterygoideus Externus.
Pterygoideus Internus.

Pterygoideus Externus (Fig. 15) arises from the outer surface of the external plate of the pterygoid process of the sphenoid bone, from the tuberosity of the superior maxilla, and from the ridge on the

Fig. 15.

sphenoid bone separating the zygomatic from the pterygoid fossa, and is inserted into the inner side of the neck of the lower jaw, and capsular ligament of the articulation.

Pterygoideus Internus arises, tendinous and fleshy, from the inner surface of the pterygoid plate, fills the greater part of the pterygoid fossa, and is inserted, tendinous and fleshy, into the inner face of the angle of the inferior maxilla and the rough surface above the angle.

The external one is triangular, having its base at the pterygoid process and running outward and backward to the neck of the con-

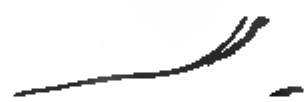
dyle. The internal is strong and thick, placed on the inside of the ramus of the jaw, and running downward and backward to the angle.

6. Lingual Group.

Genio-hyo-glossus.
Hyo-glossus.
Lingualis.
Stylo-glossus.
Palato-glossus.

The *Genio-hyo-glossus* (Fig. 16) is attached, as its name implies, to the chin, hyoid bone, and tongue. It is a triangular, fan-like muscle,

Fig. 16.



arising by its apex from the superior genial tubercle, and has its inferior fibres running parallel with the genio-hyoid to be inserted into the hyoid bone, while its middle and anterior fibres are inserted into the under surface of the tongue its whole length.

The *Hyo-glossus*, a thin, broad, quadrilateral muscle, has its *origin*

from the body, cornu, and appendix, of the os-hyoides, and is *inserted* into the side of the tongue, forming the greater part of its bulk.

The *Lingualis* has its origin on the under surface of the tongue, extending from its base and the hyoid bone to the apex, and so intermingling with the other muscles as to be considered rather a part of them than a distinct muscle.

The *Stylo-glossus* arises from the point of the styloid process and stylo-maxillary ligament. It is inserted into the side of the tongue near its root, its fibres running to the tip.

The *Palato-glossus* is more directly associated with the soft palate, and will consequently be described with the palatal group.

Fig. 17.

7. Pharyngeal Group.

Constrictor Inferior.
Constrictor Medius.
Constrictor Superior.
Stylo-pharyngeus.
Palato-pharyngeus.

The *Inferior Constrictor* of the pharynx (Fig. 17) arises from the side of the thyroid cartilage and its inferior cornu, and from the side of the cricoid cartilage, and is inserted with its fellow into the middle line on the back of the pharynx. This is the largest of the constrictor muscles, and overlaps the middle constrictor.

The *Middle Constrictor* of the pharynx (Fig. 17) arises from the appendix and both cornua of the os-hyoides, and from the thyro-hyoid ligament; its fibres ascend, run transversely and descend, giving a triangular appearance; the upper ones overlap the superior constrictor, while the lower are beneath the inferior; the whole pass back to be inserted into the middle tendinous line of the pharynx.

The *Superior Constrictor* (Fig. 17) arises from the cuneiform process of the occipital bone, from the lower part of the internal pterygoid plate of the sphenoid bone, from the pterygo-maxillary

ligament, and from the posterior third of the mylo-hyoid ridge of the lower jaw, near the root of the last molar tooth. It is inserted with its fellow into the middle tendinous line at the back of the pharynx.

The *Stylo-pharyngeus* arises from the root of the styloid process, and is inserted into the side of the pharynx and corner of the os-hyoides and thyroid cartilage. It is a long and narrow muscle, and passes to the pharynx between the upper and middle constrictors.

The *Palato-pharyngeus*, which forms the posterior pillar of the soft palate, is a long, fleshy muscle, wider at either extremity than in the middle, and arises from the soft palate by a divided fasciculus, between which points of attachment lies the levator-palati. It passes behind the tonsil, downward and outward, to be inserted into the posterior part of the thyroid cartilage, together with the stylo-pharyngeus.

The muscles of this group are supplied with nerves from the pharyngeal plexus and glosso-pharyngeal nerve; an additional branch from the external pharyngeal nerve being sent to the inferior constrictor; the palato-pharyngeus receives a branch from Meckel's ganglion.

These muscles are exercised in the act of deglutition, and also exert an influence in modulating the voice.

8. Palatal Group.

The Levator Palati.
The Tensor, or Circumflex Palati.
Constrictor Isthmi-faucium, or Palati-glossus.
Palato-pharyngeus.
Azygos-uvulæ.

The *Levator Palati* (Fig. 18) arises from the point of the petrous portion of the temporal bone and adjoining portion of the Eustachian tube, descends, and is inserted into the soft palate.

The *Tensor*, or *Circumflexus Palati*, arises from the base of the pterygoid process of the sphenoid bone and from the Eustachian tube; it descends in contact with the internal pterygoid muscle to the hamulus, round which it winds, and is inserted into the soft palate, where it expands and joins its fellow.

The *Constrictor Isthmi-faucium*, or *Palato-glossus*, occupies the anterior lateral half arches of the palate; it arises from the side of the tongue near its root, and is inserted into the velum near the uvula.

The *Palato-pharyngeus* has already been described with the muscles of the pharyngeal group.

The *Azygos-uvulæ* arises from the posterior spine of the palate bones at the termination of the palate suture, runs along the central

line of the soft palate, and ends in the point of the uvula. It raises and shortens the uvula.

It is thus seen that the various muscles of the soft palate are all concerned, more or less, in conducting the food into the pharyngeal cavity. The elevators raise the palate, and at the same time protect the posterior nares from regurgitation of the food; while the tensor puts it on the stretch, and after it has passed the velum, the constrictor isthmi-faucium and palato-pharyngeus draw the palate down, and thus close the opening into the mouth; after which the food, as already mentioned, is grasped by the constrictor muscles of the pharynx and conveyed into the œsophagus.

Fig. 18.

The *Soft Palate* is a movable curtain, composed of mucous membrane, inclosing several muscles. It is situated at the back part of the mouth between this cavity and the pharynx, is connected above

to the posterior edge of the hard palate, and laterally to the side of the tongue and pharynx.

By this arrangement, the soft palate has the appearance of a lunated or arched veil between the cavity of the mouth and the pharynx.

In the centre of this arch an oblong body is suspended, called the uvula, which divides the soft palate into lateral half arches, that pass on either side from the uvula to the root of the tongue.

There is also seen passing from the uvula on each side to the pharynx two other arches, which, from being behind the first, are called the posterior arches or pillars.

Between the anterior and posterior pillars, on either side, is a triangular interval containing the tonsil glands.

The *Fauces* are the straits or passage leading from the mouth to the pharynx; and the space included between the soft palate above, the half arches or tonsils on either side, and the root of the tongue below, is called the isthmus of the fauces.

The *Tonsils* are two bodies, each about the size of an almond, seen at the root of the tongue on its sides, occupying the cavity between the anterior and posterior arches. They consist of a group of compound follicular glands, forming somewhat oval bodies, whose enlargement constitutes an obstacle to deglutition, and by their locality near the mouths of the Eustachian tubes frequently cause obstruction and deafness.

ARTICULATIONS.

Articulation is a term used in Anatomy to denote the various modes of union between the bones of the skeleton. Articulations are classed under three general heads, namely—movable joints, immovable joints, and joints of a mixed order, the latter being somewhat movable without much relative displacement of the contiguous surfaces. The lower jaw is an example of a movable articulation which is known as the—

Temporo-maxillary Articulation.—The inferior maxillary bone articulates with the anterior portion of the glenoid cavity of the temporal bone, forming the temporo-maxillary articulation. This joint consists of the convex condyloid head or process of the inferior maxillary bone, the concave surface of the glenoid fossa, the inter-articular fibro-cartilage, a double synovial membrane, and a loose capsular ligament.

The *Capsular Ligament* is a very loose sac, attached above to the circumference of the glenoid cavity, and in front to the articular root of the zygoma; below it embraces the neck of the inferior maxillary bone, immediately below the head or condyloid process.

The *Interarticular Fibro-cartilage* is an ovoid plate placed between the bones, and is supported in position by a circumferential attachment to the common capsule, the external lateral ligament, and to the tendon of the external pterygoid muscle. Below its face is concave, corresponding with the convexity of the condyle; above it is concave in front and convex behind, corresponding with the glenoid cavity proper and the articular eminence. The composition of the circumference is fibrous with a cartilaginous centre, being frequently quite soft and sometimes perforated.

The *Synovial Membranes*, one above and the other below the interarticular fibro-cartilage, are the lubricating membranes, and in form are similar to two small sacs. They secrete the synovia, a fluid which resembles the white of an egg, but which is more oily and resistive in its nature.

The *Internal Lateral Ligament* descends from the spinous process of the great wing of the sphenoid bone, and is attached to the inner surface of the ramus.

The *Stylo-maxillary Ligament* passes behind from the styloid process of the temporal bone to be inserted just above the angle.

The *External Lateral Ligament* has its origin from the zygoma, and passes obliquely downward and backward to be inserted about the neck of the condyle; it is a short, somewhat triangular-shaped band of fibrous tissue, and assists in forming the common capsule. Externally it is very superficial, being covered only by the integuments, except in cases where the parotid gland overlaps it.

CHAPTER V.

BLOOD-VESSELS OF THE MOUTH.

THE arteries that supply the mouth come from the external carotid. This is a division of the common carotid which arises on the right side from the arteria innominata, and on the left from the arch of the aorta; after passing up the neck on either side, along the course of the sterno-cleido-mastoid muscles, it divides, on a level with the top of the thyroid cartilage, into its two great branches—the external and internal carotid arteries.

The *Internal Carotid Artery* has a tortuous course; is first to the outside and behind the external carotid; then ascends in front of the vertebral column by the side of the pharynx and behind the digastric and styloid muscles to the carotid foramen in the petrous

portion of the temporal bone; thence it traverses the canal in this bone and enters the brain, supplying it with most of its vessels, not giving any to the mouth.

The *External Carotid* extends from the top of the larynx to the neck of the condyle of the lower jaw; at first anterior and on the inside of the internal carotid, it soon gets to the outside, then passes under the digastric and stylo-hyoid muscles and lingual nerve, becomes

FIG. 19.

imbedded in the parotid gland, and terminates between the neck of the inferior maxilla and the auditory meatus in the temporal and internal maxillary arteries.

The branches of the external carotid with which we have to do are the

Lingual.
Facial.
Ascending Pharyngeal.
Temporal.
Internal Maxillary.

The *Lingual Artery* arises from the external carotid, between the superior thyroid and facial; passing obliquely up to the great corner of the hyoid bone, it runs parallel with, and ascending perpen-

dicularly to the base of the tongue, continues its course to the tip of that organ, under the name of the ranine artery. This part of the artery lies just beneath the mucous membrane, and is in danger of being wounded in division of the frænum in children. This accident may be avoided by using blunt-pointed scissors, and directing the points downward and backward.

The hypo-glossal nerve accompanies this artery.

The branches of the lingual artery with which we are concerned are the

Dorsalis Linguæ.
Sublingual.
Ranine.

The *Dorsalis Linguæ* arises from the lingual artery, beneath the hypo-glossus muscle, and is distributed to the tonsil, epiglottis, soft palate and mucous membrane of the tongue.

The *Sublingual* arises from the lingual at the point of bifurcation, near the anterior margin of the hyo-glossus muscle, and passes forward to be distributed to the sublingual gland, to the mucous membrane of the mouth and gums, and to the neighboring muscles.

The *Ranine* may be considered the continuation of the lingual. It passes along the inferior surface of the tongue, just beneath its mucous membrane. At the tip of the tongue it anastomoses with its fellow of the opposite side. It is accompanied by the gustatory nerve.

The *Facial Artery* is the third branch of the external carotid. It ascends to the submaxillary gland, behind which it passes on the body of the lower jaw; thence it goes in front of the masseter muscle to the angles of the mouth, and finally terminates at the side of the nose by anastomosing with the ophthalmic arteries.

In its course it gives off the submental, inferior labial, superior and inferior coronary arteries, which mainly supply the elevators, depressors and circular muscles of the mouth. The branches of the facial artery are divided into two sets:—

CERVICAL BRANCHES.	FACIAL BRANCHES.
Inferior or Ascending Palatine.	Muscular.
Tonsillitic.	Inferior Labial.
Submaxillary.	Inferior Coronary.
Submental.	Superior Coronary.
	Lateralis Nasi.
	Angular.

The *Inferior Palatine* passes up between the stylo-glossus and stylopharyngeus muscles, which it supplies, to give branches to the tonsil, Eustachian tube, soft palate and palatine glands, anastomosing

with the tonsillitic artery and with a branch of the internal maxillary.

The *Tonsillitic Artery* is distributed to the tonsil and root of the tongue.

The *Submaxillary* supplies the submaxillary gland, together with the neighboring lymphatic glands, muscles and integuments.

The *Submental* is the largest of the cervical branches of the facial artery; it is given off from it just as it emerges from the submaxillary gland, and, passing along the lower border of the inferior maxilla, is distributed to the muscles attached to the jaw, and terminates in a superficial and deep branch; the former of which is distributed to the depressor labii inferioris and integument, anastomosing with the inferior labial; the latter is also distributed to the lip, and anastomoses with the inferior labial and mental arteries.

The *Facial* branches are distributed to the muscles of the face. The muscular to the pterygoid, masseter and buccinator muscles. The superior coronary to the upper lip, giving branches to the septum and ala nasi. The inferior coronary passes to the lower lip, and anastomoses with its fellow of the opposite side. The lateralis nasi supplies the wing and back of the nose. The angular is the terminal branch of the facial. It supplies the cheek, lachrymal sac and orbicularis palpebrarum muscle, and terminates by anastomosing with the ophthalmic by its nasal branch.

The *Ascending Pharyngeal*, the smallest of the external carotid branches, is given off from the posterior part of the external carotid, passes up beneath its other branches and the stylo-pharyngeus muscle to the base of the skull; it has three sets of branches—the external, meningeal and pharyngeal. To the latter only do I wish to direct attention.

The *Pharyngeal* branches are three or four in number, two of which are distributed to the middle and inferior constrictors and to the stylo-pharyngeus, and their mucous membrane. The largest branch supplies the tonsil, Eustachian tube and soft palate, substituting the palatine branch of the facial when it is absent or of small size.

The *Temporal Artery* gives off a transverse facial branch just before it emerges from the parotid gland, which is distributed to that gland, the masseter muscle and the integument, terminating by anastomosis with the facial and infra-orbital arteries.

The *Internal Maxillary Artery* commences in the substance of the parotid gland; then goes horizontally behind the neck of the condyle of the lower jaw to the pterygoid muscles, between which it passes, and then proceeds forward to the tuberosity of the superior

maxillary bone; from thence it takes a vertical direction upward between the temporal and external pterygoid muscles to the zygomatic fossa, where it again becomes horizontal, and finally ends in the spheno-maxillary fossa by dividing into several branches.

The branches of this artery which we shall describe are the—

Inferior Dental.	Alveolar.
Infra-orbital.	Descending Palatine.

The *Inferior Dental Artery* enters the inferior dental foramen of the lower jaw, passes along the dental canal beneath the roots of the teeth; sending up, in its course, a twig through the aperture of each to the pulp of the teeth, and finally escapes at the mental foramen on the chin; a branch of it, however, continues forward to supply the incisors. After emerging from the mental foramen, it supplies the muscles and integument of the chin and anastomoses with the inferior labial, submental, and inferior coronary arteries. Before entering the dental foramen a large branch, the mylo-hyoid, which lies in a groove of the same name on the inner surface of the maxillary bone and is lost on the under surface of the mylo-hyoid muscle, is given off.

The *Alveolar* is given off from the internal maxillary by a trunk common to it and the infra-orbital, just before it enters the spheno-maxillary fossa. At the tuberosity of the superior maxillary bone it divides into numerous branches, some of which, passing into the alveolar foramina, supply the bicuspid and molar teeth; others pierce the bone to supply the antrum, while some are distributed to the gums.

The *Infra-orbital Artery* enters the infra-orbital canal, traverses its whole extent, and comes out at the foramen of the same name, upon the face; just before it emerges it sends through the anterior dental canal a twig for the incisors and cuspids, having previously given branches to the inferior rectus and inferior oblique muscles and to the lachrymal gland; also other branches to the lining membrane of the antrum. After escaping from the orbit, it supplies the lachrymal sac and neighboring tissues and anastomoses with the facial, nasal branch of the ophthalmic, and with the transverse facial and buccal branch.

The *Descending Palatine* passes along the posterior palatine canal, accompanied by palatine branches of Meckel's ganglion; emerging thence it runs along a groove on the inner border of the alveoli, and is distributed to the mucous membrane of the hard palate, to the gums and the palatine glands. In the posterior palatine canal it gives off branches, which pass along the accessory palatine canal

to be distributed to the soft palate. In front it terminates in a small branch which enters the anterior palatine canal, through which it passes to reach the septum naris, where it unites with a branch of the spheno-palatine.

The *Veins* correspond so nearly, both in name and course, with the arteries, that a description of them would only be a repetition of what has been said; suffice it, therefore, to observe, that there are two companion veins with every considerable artery, and that the venous branches are mostly collected at the angle of the jaw into a common trunk called the external jugular vein, which passes down the neck in the course of the fibres of the platysma muscle, and terminates in the subclavian vein at the posterior edge of the sterno-mastoid muscle.

The office of the veins is to return the blood to the heart.

CHAPTER VI.

THE NERVES OF THE MOUTH.

THE *Cranial Nerves* pass in pairs through the foramina in the base of the skull. According to the order of succession from before backward, they are known as the first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, eleventh and twelfth pairs.

FIG. 20.

The nerves supplying the mouth belong to the fifth pair, and the portio dura of the seventh pair or facial nerve.

The *Fifth* (Trigemini) is the largest of the cranial nerves, and

gives sensibility to all the organs concerned in the primary stages of digestion.

This nerve will also be found to be a compound nerve, having motor filaments as well as sensitive, and thereby giving motion as well as sensation. It is also a nerve of special sense.

It is first seen at the side of the pons Varolii near its junction with the crura-cerebelli, but its origin is much deeper and further back. It arises by two unequal roots, one of which may be traced through the pons Varolii into the lateral tract behind the olivary body; the smaller, or *motor root*, is lost in the medulla oblongata. From its origins this nerve has been called a cranial-spinal nerve.

These two fasciculi, the one anterior and the other posterior, constitute the fifth nerve, which consists of eighty or one hundred filaments that pass forward and outward, in a canal formed of dura mater, to a depression on the anterior surface of the petrous bone.

At this point it spreads into a ganglion, called the Casserian ganglion, on the under surface of which is seen the anterior root; but it has no intimate connection with the ganglion, and can be traced on, as will be presently shown, to the inferior maxillary nerve.

The Casserian ganglion receives filaments from the carotid plexus of the sympathetic, and gives off several minute branches to the dura mater and tentorium cerebelli. Three large branches are given off from its anterior border, the ophthalmic and superior and inferior maxillary. The ophthalmic and superior maxillary are exclusively nerves of sensation, their fibres being derived entirely from the posterior or sensory root, whilst the inferior maxillary receives fibres from both roots, and is consequently more variously endowed.

The *Ophthalmic Nerve* is a short trunk that enters the orbit through the foramen lacerum superius. It supplies the eyeball, the mucous membrane of the eye and nose, and the lachrymal gland, also the muscles and integument of the eyebrow and forehead. It is a sensitive nerve; is the first given off from the Casserian ganglion, and is the smallest of the three branches. It receives a few filaments from the cavernous plexus of the sympathetic, and divides into three principal branches—

1. The Frontal,
2. The Lachrymal, and
3. The Nasal.

The *Frontal*, which is the largest branch of the ophthalmic, passes along the roof of the orbit to the supra-orbital foramen, through which it passes, and is then called the supra-orbital nerve, and is

spent on the muscles and integuments of the forehead. It gives off several branches in its course.

The *Lachrymal*, the smallest branch of the ophthalmic, generally arises by two branches, one from the fourth nerve and the other from the ophthalmic. It enters the orbit through the sphenoidal fissure, receives a communicating branch from the superior maxillary, and is finally distributed to the lachrymal gland, taking the

Fig. 21.

outward direction, and sending branches in its course to the upper eyelid, conjunctiva, and other parts, receiving on the eyelid branches from the facial.

The *Nasal* takes its direction along the inner side of the orbit to the anterior ethmoidal foramen, through which it passes into the cranium, on the upper surface of the cribriform plate of the ethmoidal bone; descends by the side of the crista-galli through a slit-like

opening into the nose, and there terminates by filaments which are spent upon the septum, mucous membrane, anterior nares, etc. It sends off several branches in its course; one in particular to the lenticular ganglion at the bottom of the eye, others to the caruncula lachrymalis, lachrymal sac, conjunctiva, etc.; but as these do not belong to the mouth and dental apparatus, we will pass to the second great division of the fifth.

The Superior Maxillary Nerve.—This nerve proceeds from the middle of the Casserian ganglion, passes through the foramen rotundum of the sphenoid bone into the pterygo-maxillary fossa; here it enters the canal of the floor of the orbit—the infra-orbital canal—traverses its whole extent, and emerges on the face at the infra-orbital foramen, where it terminates in numerous filaments in the muscles and integuments of the upper lip, cheek, lower eyelid and side of the nose.

The superior maxillary nerve supplies the upper jaw, and gives off many important branches, which are as follows:

In the pterygo-maxillary fossa two branches descend to a small reddish body called the ganglion of Meckel, or the spheno-palatine ganglion, situated on the outer side of the nasal or vertical plate of the palate bone.

From this ganglion proceed three sets of branches:—

1. Inferior, Descending or Palatine Nerves.
2. Nasal or Spheno-palatine.
3. Posterior, Pterygoid or Vidian.

The *Palatine Nerves* descend through the posterior palatine canal, come out at the posterior palatine foramen, along with an artery of the same name, and supply with filaments the soft palate, uvula, tonsils, the roof of the mouth, and the inner alveoli and gums.

The *Nasal Nerves* enter the nose through the spheno-palatine foramen, and divide into several filaments, which enter the mucous membrane covering the upper and lower turbinated bones and vomer; one long branch can be traced along the septum nasi, as far as the foramen incisivum, where it meets the anterior palatine branches in a ganglion called the naso-palatine.

The *Vidian*, or *Pterygoid*, passes backward from the ganglion of Meckel through the pterygoid canal at the root of the pterygoid process; then enters the cranium through the foramen lacerum anterius, and divides into two branches, one of which enters the carotid canal and unites with the sympathetic branches of the superior cervical ganglion, thus connecting this ganglion with the ganglion of Meckel.

The other, the proper vidian nerve, enters the vidian foramen or

hiatus Fallopii in the petrous bone, joins the portio dura nerve, accompanies this as far as the back part of the tympanum; then leaves it, enters the cavity of the tympanum, and receives there the name of *Chorda Tympani*. It leaves this cavity by the glenoid fissure, then joins the gustatory nerve, continues with it to the submaxillary gland, where it leaves it, and is lost in the submaxillary ganglion, situated at the posterior part of the submaxillary gland.

The exceedingly intricate course of the vidian nerve is interesting from the number of communications which it establishes between different and distant parts; for it unites the ganglion of Meckel with the superior cervical ganglion of the sympathetic, and both with the submaxillary ganglion; it also connects the superior and inferior maxillary nerves to one another and to the portio dura.

The *Superior Maxillary Nerve* gives off next in the spheno-maxillary fossa—

1. The Orbital.
2. The Posterior Dental.
3. The Anterior Dental.

The *Orbital* enters the orbit through the spheno-maxillary fissure, and then sends off a *malar* and *temporal* branch, which pass out through the malar bone; the first supplying the cheek, the latter accompanying the temporal artery to the integuments of the side of the head, receiving filaments from the facial and auriculo-temporal branch of the inferior maxillary.

The *Posterior Dental Nerves*, two in number, descend on the tuberosity of the superior maxillary bone, and enter the posterior dental canals to supply the bicuspid and molar teeth; one branch penetrates the antrum and courses along the outer wall, anastomosing with the anterior dental nerves, while another runs along the alveolar border, supplying the gums.

The *Anterior Dental* is given off from the superior maxillary, just before it escapes from the infra-orbital foramen. It anastomoses with the posterior dental, and sends filaments to the incisor, canine and first bicuspid teeth; others are sent to the mucous membrane of the inferior meatus.

This nerve now emerges, as before mentioned, at the infra-orbital foramen, between the levator labii superioris alæque nasi and levator anguli muscles, dividing here into many branches, some of which ascend to the nose and eyelids, others pass downward and outward to the lip and cheek, anastomosing with the nasal branch of the ophthalmic and the facial branches of the portio dura.

Inferior Maxillary Nerve.—This nerve forms the third great division of the fifth. It is the largest branch, and passes from the ganglion of Casser, through the foramen ovale of the sphenoid bone, to the zygomatic fossa.

This nerve, as stated, is attached to the anterior or motor root, and they come together on the outside of the foramen ovale; then in the zygomatic fossa, the inferior maxillary nerve divides into two branches:—

1. Anterior.
2. Posterior.

The *Anterior* is the motor branch, and gives off the following filaments to the several muscles:—

1. *Masseteric*, crossing the sigmoid notch to the masseter muscle.
2. *Temporal*, anterior and posterior deep, to the temporal muscle and fascia.
3. *Buccal*, to the buccinator, external pterygoid, and temporal muscles.
4. *Pterygoid*, to the pterygoid muscles.

The *Internal* division of the inferior maxillary nerve consists of three branches, all of which are sensitive; they are—

1. The Anterior Auricular.
2. The Gustatory.
3. The Inferior Dental.

The *Anterior Auricular* passes behind the neck of the lower jaw and in front of the meatus of the ear, and ascends through the parotid gland, over the zygoma, along with the temporal artery, and divides into anterior and posterior branches.

In its course it unites with the facial nerve, and supplies the parotid gland, the articulation of the lower jaw, the meatus, and cartilages of the ear and side of the head.

The *Gustatory Nerve*, the nerve of the special sense of taste, immediately after its origin sends a branch to the inferior dental; it then descends between the pterygoid muscles, where the chorda tympani joins it; it now passes along the ramus of the lower jaw, covered by the internal pterygoid muscle, then above the submaxillary glands, and forward above the mylo-hyoid and between it and the hyo-glossus muscles, accompanied by the duct of Wharton; and finally ascends above the sublingual gland to the lateral, inferior and anterior parts of the tongue.

In its course, Mr. Harrison enumerates the following branches as given off by this nerve:—

"First, one or two small filaments to the internal pterygoid

muscle. Second, several to the tonsils, to the muscles of the palate, to the upper part of the pharynx, and to the mucous membrane of the gums. Third, the chorda tympani, and some accompanying filaments to form a plexus, which supplies the submaxillary gland. Fourth, a few branches which descend along the hyo-glossus muscle to communicate with the ninth or lingual nerve. Fifth, a fasciculus of nerves to the sublingual gland and to the surrounding mucous membrane. Lastly, at the tongue it divides into several branches; some pass deep into the tissue of this organ; others, firm and soft, rise toward its surface, and are lost in the mucous membrane and in a small conical papilla near its tip."

The *Inferior Dental Nerve* passes between the pterygoid muscles, then along the ramus of the lower jaw under the pterygoideus internus to the inferior dental foramen, which it enters along with an artery and vein; it now traverses the inferior dental canal, sending twigs into all the roots of the molars and bicuspids. Opposite the mental foramen it divides into two branches; the smaller is continued forward in the substance of the jaw to supply the roots of the cuspids and incisors; while the larger comes out at the mental foramen, is distributed to the muscles and integuments of the lower lip, and finally communicates with the facial nerve.

The inferior dental, just as it enters the posterior dental foramen, gives off the *mylo-hyoid* nerve; this passes forward in a groove of the lower jaw, and supplies the mylo-hyoid and digastric muscles, and occasionally the submaxillary gland.

The Facial Nerve.—The *Portio dura* of the seventh or facial nerve is the last nerve to be noticed as particularly belonging to the mouth.

The *Facial Nerve* arises from the medulla oblongata between the olivary and restiform bodies, close behind the lower margin of the pons Varolii; it then passes forward and outward with the portio mollis to the foramen auditorium internum, which it enters and passes on to the base of this opening; here these two nerves separate, the portio mollis going to the labyrinth of the ear, while the facial enters the aqueduct of Fallopius, in which it is joined by the vidian. Within the aqueductus Fallopii it gives off two branches—the tympanic and chorda tympani. The former supplies the stapedius muscle. The latter passes along a distinct canal and enters the cavity of the tympanum near the attachment of the membrana tympani, where it is covered by mucous membrane. It escapes from this cavity by the inner side of the Glasserian fissure; after receiving a communicating branch from the gustatory nerve it

passes to the submaxillary gland, then joining the submaxillary ganglion it is lost in the lingual muscle. The facial then goes in a curved direction outward and backward behind the tympanum, where it parts with the vidian, and proceeds on to the stylo-mastoid

FIG. 22.

foramen, from which it emerges. At this point it sends off three small branches.

1. The Posterior Auricular,
2. The Stylo-hyoid, and
3. The Digastric.

The *Posterior Auricular* ascends behind the ear, crosses the mastoid process, where it receives branches from the pneumogastric, and the auricularis magnus; it then divides into two branches, one of which passes to the retrahens aurem, the other to the occipito-frontalis muscle.

The *Stylo-hyoid* is distributed to the stylo-hyoid muscle. It communicates with filaments of the sympathetic sent to the carotid artery.

The *Digastric* is distributed to the posterior belly of the digastric muscle, receiving a communicating branch from the glosso-pharyngeal.

The facial nerve, while deeply imbedded in the substance of the parotid gland, divides into two sets of branches, of which one is superior and the other inferior; these two, by frequent unions, form the *pes anserinus* or *parotidean plexus*, and send branches to the whole of the side of the face.

The upper division, called the temporo-facial, ascends in front of the ear upon the zygoma, accompanies the temporal artery, and its branches, supplying the side of the head, ear, and forehead, and anastomosing with the occipital and supra-orbital nerves; a set of branches pass transversely to the cheek, furnishing the lower eyelid, lips, and side of the nose, and uniting with the infra-orbital nerve.

The inferior or cervico-facial division descends, supplying the lower jaw and upper part of the neck, giving off the following branches:—

1. Buccal,
2. Inferior Maxillary, and
3. Cervical.

The *Buccal*, or superior branches, supply the muscles of the cheek, nose, and upper lip.

The *Inferior Maxillary* nerves are distributed in the muscles of the chin and lower lip, and by means of anastomotic branches communicate with the inferior dental nerve.

The *Cervical* branches form a close connection with the superior cervical nerves, and supply the platysma myoid and the levator labii superioris muscles.

The facial is the motor nerve of the face, and by its means the passions or emotions find their expression in the peculiar action of the muscles to which it is distributed.

In consequence of the numerous communications which this nerve has with other nerves, the name of *Sympatheticus Minor* has been given to it by some anatomists.

Mr. Gray furnishes the following concise statement of these communications:

In the internal auditory meatus, .	With the auditory nerve.
In the aquæductus Fallopii, .	With Meckel's ganglion by the large petrosal nerve. With the optic ganglion by the smaller petrosal nerve. With the sympathetic on the middle meningeal by the external petrosal nerve.
At its exit from the stylo-mastoid foramen, ...	With the pneumogastric. " " glosso-pharyngeal. " " carotid plexus. " " auricularis magnus. " " auriculo-temporal.
On the face, ...	With the three divisions of the fifth.

CHAPTER VII.

SALIVARY GLANDS AND SALIVA.

THE Salivary Glands are six in number, three on each side of the face, named the *Parotid*, *Submaxillary* and *Sublingual.*

These glands are the prime organs in furnishing the salivary fluids to the mouth during the process of mastication.

The *Parotid Gland* (Fig. 23), so called from its situation near the ear, is the largest of the salivary glands. Its form is very irregular; it fills the space lying between the ramus of the inferior maxilla and mastoid process of the temporal bone, as far back as, and even behind, the styloid process of the same bone. Its extent of surface is from the zygoma above to the angle of the lower jaw below, and from the mastoid process and meatus behind to the masseter muscle in front, overlapping its posterior portion. It weighs between five and eight drachms, and is separated from the submaxillary gland by the stylo-maxillary ligament; but sometimes the two glands are continuous.

This gland is one of the conglomerate order, and consists of numerous small lobes connected together by cellular tissue, each of which may be considered a small gland in miniature, as each is supplied with an artery, vein and excretory duct.

This gland thus formed presents on its external surface a pale, flat and somewhat convex appearance.

It is covered by a dense, strong fascia, extending from the neck, and attached to the meatus externus of the ear, which sends countless processes into every part of the gland, separating its lobules and conducting the vessels through its substance.

The use of this gland is to secrete or separate from the blood the greater part of the saliva furnished to the mouth. As the parotid is, however, on the outside, and at some little distance from the mouth, it is furnished with a duct to convey its fluid into this

FIG. 28.

cavity; this duct is called the duct of Steno, or the parotid duct. It is formed of the excretory ducts of all the granules composing this gland, which, successively uniting together, at last form one common duct.

The duct of Steno commences at the anterior part of the gland and passes over the masseter muscle, on a line drawn from the lobe of the ear to the middle part of the upper lip; then passes through a quantity of soft adipose matter, and finally enters the mouth by passing through the buccinator muscle and mucous membrane, opposite the second molar of the upper jaw.

The diameter of this duct is about that of a crow-quill, but its orifice is small and contracted, and is concealed by a fold of mucous membrane. It is thick and strong, and is more exposed to injury than the duct of the submaxillary gland.

The arteries supplying this gland are from the external carotid or some of its branches.

The nerves are derived from the carotid plexus of the sympathetic, and from the facial, temporal, and great auricular.

The parotid secretion is a clear, watery, alkaline liquid, which is poured out abundantly during mastication, but in very small quantity when the mouth is at rest. Its secretion may also be excited by mental emotion, as when observing a savory article of food, or by artificial stimuli, as of glass beads or other irritants in the mouth.

The following analysis is taken from Dalton's Physiology:

COMPOSITION OF HUMAN PAROTID SALIVA.

Water,	983.308
Organic Matter precipitable by alcohol,	7.352
Substance destructible by heat, but not precipitated by alcoholar acids,	4.810
Sulpho-cyanide of Sodium,	0.330
Phosphate of Lime,	0.240
Chloride of Potassium,	0.900
Chloride of Sodium and Carbonate of Soda,	3.060
Total,	1000.000

It will be seen that the quantity of organic matter is comparatively large.

Observation has shown that this secretion is unilateral, the saliva flowing only from that side on which mastication is then being conducted, and that the quantity is directly related to the physical character of the food, and not to its chemical constitution, being more or less abundant, according to the dryness of the food.

The *Submaxillary* is the next in size of the salivary glands. It is situated under and along the inferior edge of the body of the lower jaw, and is separated from the parotid by the stylo-maxillary ligament.

The submaxillary gland is partially concealed by the jaw when the head is in the natural position, and weighs about two drachms. It is divided into several lobes, and the facial artery occupies a groove on its deeper surface, and also upon its upper border.

It is of oval form, pale color, and, like the parotid, consists in its structure of small lobules, held together by cellular tissue; each

having a small excretory duct, which, successively uniting with one another, finally form one common duct. This, the duct of Wharton, passes above the mylo-hyoid muscle, and running forward and inward, enters the mouth below the tip of the tongue at a papilla seen on either side of the frænum linguæ.

The use of this gland is the same as the parotid, to secrete a fluid constituent of the saliva, and its duct is the route by which it is conducted into the mouth. Its arteries are derived from the facial and lingual. The veins correspond. Its nerves are received from the submaxillary ganglion, the inferior dental and sympathetic nerves.

The *Sublingual Glands* are the last in order of the salivary glands, and the smallest in size.

They are situated beneath the anterior and lateral parts of the tongue, are covered by the mucous membrane, and rest upon the mylo-hyoid muscle. Each sublingual gland is oblong in shape and weighs about one drachm.

The Sublingual Glands, like the two glands just described, consist of a lobular structure with excretory ducts; which, however, do not unite into one common duct, but enter the cavity of the mouth by many ducts (ducts of Rivinius), from eight to twenty in number, whose openings are through the mucous membrane between the tongue and the inferior cuspid and bicuspid teeth.

These ducts terminate by minute openings behind the orifice of the submaxillary duct along the ridge upon the floor of the mouth. One or more of these ducts enter the submaxillary duct, and one is known by the name of the *duct of Bartholin.*

Their office is the same as the parotid and submaxillary. Their arteries are derived from the sublingual and submental. Their nerves from the gustatory; salivary glands are found in all vertebrate animals except fishes.

The *Mucous Glands.*—Besides the glands furnishing the saliva, there is another series of much smaller size, called the *mucous glands.* They are simply the little crypts, follicles, or depressions everywhere found in the mucous membrane of the mouth, and named, according to their situation, the glandulæ labiales, glandulæ buccales, etc. The lips, cheeks, and palate are also furnished with glands about the size of a small pea, which present the true salivary structure.

The use of these glands is to furnish the mucus of the mouth, which they pour into this cavity by single orifices, opening everywhere on its surface.

The *Saliva* consists of the commingled secretion of all these

glands. It is a glairy, slightly opalescent, alkaline fluid, consisting of organic and mineral substances held in solution with water. Its composition, according to Bidder and Schmidt, is as follows:

COMPOSITION OF SALIVA.

Water,	995.16
Organic Matter,	1.84
Sulpho-cyanide of Potassium,	0.06
Phosphate of Soda, Lime, and Magnesia,	.98
Chlorides of Sodium and Potassium,	.84
Mixture of Epithelium,	1.62
	1000.00

Two kinds of organic matter exist in the saliva; the first, which is found in the submaxillary and sublingual secretions, is called *ptyaline;* to it the saliva owes its viscidity. Alcohol coagulates it, but heat does not, differing, in this respect, from the organic matter derived from the parotid gland, which is coagulated by heat and is not viscid.

Sulpho-cyanogen, the only mineral ingredient that is peculiar to saliva, is detected by a solution of the chloride of iron, with which it strikes a red color characteristic of it.

When saliva has stood for some time it deposits a whitish flocculent sediment, which is found under the microscope to consist of epithelium scales, and other small nucleated cells, granular matter, and oil globules. Although saliva possesses the power to change the starchy matter of the food into sugar, yet in view of the facts that this change is interrupted by the gastric juice with which it is so soon to come in contact, and that the quantity secreted is directly related to the physical characteristics of the food, and not to its chemical constitution, not being more abundant during the mastication of starchy food, except it be dry, than of any other aliment, and, furthermore, since the conversion of starch into sugar is otherwise provided for, it may be considered an established fact that its only purpose is to aid mechanically in mastication and deglutition by moistening and lubricating the food. The quantity of saliva secreted daily has been variously estimated by different observers. Mitscherlich thought it about fourteen ounces daily, and Todd and Bowman consider his estimate reliable. Bidder and Schmidt estimated it at about three and a half pounds avoirdupois, and Mr. Dalton at "rather less than three pounds avoirdupois," which is probably very nearly correct.

The *Buccal Glands* in structure resemble the salivary, and also the labial found beneath the mucous membrane of the lips, though somewhat smaller than the latter. The buccal glands are situated between the buccinator muscle and the mucous membrane.

The *Molar Glands*, three or four in number, are situated between the masseter and buccinator muscles, and their secretion, which is mucous, is conveyed to the mouth by ducts which open near the third molar teeth.

CHAPTER VIII.

THE TONGUE.

The *Tongue* is a very complicated organ; it consists of a great variety of parts, and performs a great variety of functions; it is one of the organs of deglutition; a glandular organ, to secrete; a sentient organ, to feel and taste; and likewise an intellectual organ, to assist in producing speech.

FIG. 24.

"UPPER SURFACE OF THE TONGUE" WITH THE FAUCES AND TONSILS.
1. Papillæ circumvallatæ. 2. Papillæ fungiformes.

The tongue is divided into apex, body and root; the apex is the anterior free and sharp portion; the root, which is thin, is attached to the os hyoides and is posterior; while the body, which occupies the centre, is thick and broad; it is confined in its situation by the

origin of its component muscles and by reflections of the mucous membrane.

The mucous membrane of the tongue covers its free surface everywhere; it is thinnest on its under surface, where it may be traced along the ducts of the submaxillary and sublingual glands. Passing over the dorsum, it assumes a papillary character, and becomes much thickened.

The papillæ of the tongue are the papillæ circumvallatæ, papillæ fungiformes, and papillæ filiformes.

The papillæ circumvallatæ (maximæ) are situated on each side of the back part of the tongue, meeting at the foramen cæcum so as to form a triangular figure. They number from eight to fifteen.

Each papillæ is arranged in the form of an inverted cone, with its apex received into a depression of mucous membrane, and its base exposed on the free surface, and upon it may be seen numerous smaller papillæ.

The papillæ fungiformes are scattered irregularly over the surface of the tongue, but are most numerous at its sides and apex. They also are studded on their free surface with smaller papillæ.

The papillæ filiformes are found on the anterior two-thirds of the tongue, and are very minute. They are somewhat conical or filiform in shape, are covered with an unusually dense epithelium which gives them a whitish appearance, and are filled with secondary papillæ. Small hairs are often found in them.

Structure of the Papillæ.—They consist of papillary loops, through which nerves are abundantly distributed, covered by a homogeneous tissue, upon which is superposed a thick layer of squamous epithelium.

The nerves are large and numerous in the papillæ circumvallatæ; in the papillæ fungiformes and papillæ filiformes they are smaller.

In the mucous membrane are also found follicles or glands. The former are very numerous, especially so between the circumvallate papillæ and the epiglottis, but are found scattered over the entire surface of the tongue. The latter, called mucous or lingual glands, are most abundant on the posterior third of the tongue, but are found also on its tip, sides, and in the neighborhood of the circumvallatæ papillæ. The ducts open on the free surface of the mucous membrane.

THE MUCOUS MEMBRANE LINING THE MOUTH.

The whole interior cavity of the mouth, palate, pharynx, and lips, is covered by mucous membrane, forming folds or duplicatures

at different points, called fræna or bridles. Beginning at the margin of the lower lip, this membrane can be traced lining its posterior surface, and from thence reflected on the anterior face of the lower jaw, where it forms a fold opposite the symphysis of the chin —the frænum of the lower lip; it is now traced to the alveolar ridge, covering it in front, and passing over its posterior surface, where it enters the mouth. Here it is reflected from the posterior symphysis of the lower jaw to the under surface of the tongue, where it forms a fold or bridle, called the *frænum linguæ.* It now spreads over the tongue, covering its dorsum and sides to the root, from whence it is reflected to the epiglottis, forming another fold; from this point it can be followed, entering the glottis and lining the larynx, trachea, etc.

In the same way, commencing at the upper lip, it is reflected to the upper jaw, and at the upper central incisors, forming a fold, the *frænum* of the upper lip; from this it passes over the alveolar ridge to the roof of the mouth, which it completely covers, and extends as far back as the posterior edge of the palate bones; from this it is reflected downward over the soft palate, or, more strictly speaking, the soft palate is formed by the duplicature of this membrane at this point, between the folds of which are placed the muscles of the palate already described.

From the palate it is traced upward and continuous with the membrane lining the nares, and downward with the same, lining the pharynx, œsophagus, stomach and intestinal canal.

The mucous membrane, after entering the nostrils and lining the roof, floor, septum nasi and turbinated bones, enters the maxillary sinus, between the middle and lower spongy bones, and lines the whole of this great and important cavity of the superior maxilla.

Many mucous glands or follicles, already enumerated, are scattered over the whole of this membrane, and furnish the mouth with its mucus.

The mucous membrane of the mouth, which is directly concerned in the development of the teeth, and afterwards is in close relation with these organs, is composed of different layers, as follows:

Epithelium. $\begin{cases}\text{Corneous.}\\ \text{Malpighian.}\end{cases}$

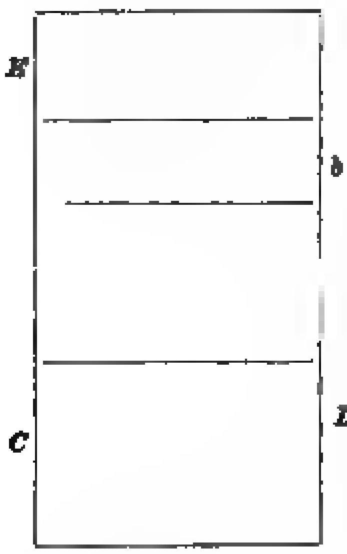
Basement Membrane.

Corium or Proper Mucous Membrane. $\begin{cases}\text{Papillary.}\\ \text{Reticulary.}\end{cases}$

Submucous Areolar Tissue.

The epithelium, which corresponds to the epidermis of the skin, and is derived from the same source, is composed of two layers, an external and an internal. The external layer, of horny consistence, and known as the corneous layer—*stratum corneum*—is formed of old epithelial cells, which, owing to changes from prismatic or columnar cells during their migration from the internal to the external surface of the membrane, have become thin, devitalized scales, devoid of function. These old epithelial cells are being continually cast off as effete matter, others taking their places, which in turn undergo a similar process of devitalization and exfoliation.

Fig. 25.



DIFFERENT LAYERS OF MUCOUS MEMBRANE.

E, epithelium; *b m*, basement membrane; *C*, corium; *D*, submucous areolar tissue.

The epithelium of the mouth is analogous in form to the skin, and the slight modification is due to its immersion in the oral fluids, which prevents its external layer from assuming the horn-like or corneous nature of the same layer of the skin. The epithelial cells are united in layers by an intercellular cement-substance, and the superficial layer, which is composed of thin scales or disks, contains nuclei, differing, in this respect, from the corneous layer of the skin, which does not usually contain nuclei.

The internal or Malpighian layer is formed of living epithelial scales or cells, which are of various forms and sizes, and are placed vertically upon the "basement membrane," which separates the epithelium from the corium (proper mucous membrane). The cells of this internal layer are variously designated as the prismatic, columnar, cylindrical or Malpighian layer, and have large nuclei, but are destitute of a cell-wall. This layer constitutes the peripheral portion of the enamel organ, which during the development of a tooth is known as the "enamel membrane."

Fig. 26.

CELLS COMPOSING THE STRATUM CORNEUM OR EXTERNAL LAYER OF EPITHELIUM (FROM FREY).

The basement membrane, known as the *membrana præformativa* of Raschow, is situated below the internal or Malpighian layer, and is a homogeneous structure, which in some parts partakes of the character of a membrane, especially where it is of considerable thickness.

Although not usually recognized as a layer of the mucous mem-

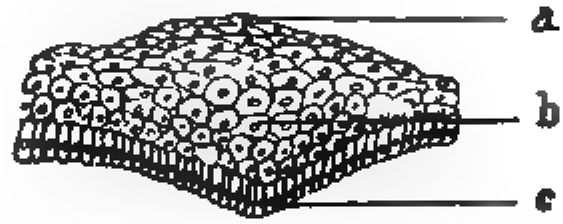
brane, yet it is interesting from the fact that the dentine bulb or

FIG. 27.

INTERNAL OR MALPIGHIAN LAYER OF THE EPITHELIUM.

a, infant cells, known as prismatic, columnar or cylinder cells; *b*, intermediate matter; *d*, fibrous tissue of the corium.

FIG. 28.



a, flat layer of epithelial cells thrown upward into the "burrelet" of Legros and Magitot; *b*, enlargement and proliferation of cells in cuboidal layers, forcing flat layer upward and columnar layer downward; *c*, columnar layer of cells directly over position which will be occupied by future jaw.

germ and the enamel organ are found on the opposite sides of it, the former below and the latter above it.

The Corium or *mucosa*, which is the proper mucous membrane, is situated beneath the basement membrane, and is analogous to the derma of the skin. It consists of a fibro-vascular layer of variable thickness, merging into the submucous areolar tissue, and contains, besides the white and yellow fibrous tissue and the vessels, muscular fibre cells (forming what is known in some localities as the *muscularis mucosæ*), nerves and lymphatics.

FIG. 29.

a

b

bm

c

a, stratum corneum; *b*, stratum Malpighii; *b m*, basement membrane; *c*, corium.

Mucous glands project from its surface, and with the processes known as villi and papillæ, common to mucous membrane covering the tongue, are analogous to the papillæ of the skin.

THE GUM.

The gum is composed of dense, elastic, fibrous tissue, adhering to the periosteum of the alveolar tissue. It is remarkable for its insensibility and hardness in the healthy state, but exhibits great tenderness upon the slightest injury when diseased. The gum differs in texture from that of the mucous membrane lining the inside of the lips, covering the floor of the mouth and the palate, of which it is a continuation, by being thicker and denser, and of less sensibility. Its hardness is due, in a great measure, to the numerous tendinous fasciculi in its substance, and also to its being closely blended with the dense fibrous fasciculi of the periosteum, which causes it to closely adhere to the bone. These fasciculi of the gum, arising from the periosteum, expand in fan-like form as they

approach the epithelial surface. The substance of the gum contains broad-based papillæ, either single or compound, and the epithelium is formed of laminæ of tassellated cells, very much flattened near the surface, but with cylindrical cells composing the Malpighian or deepest layer. The gums are very vascular, being freely supplied with vessels, but with few nerves. A free margin of gum, about half a line in width, surrounds the base of each tooth, and they present a festooned appearance, caused by elongations in the inter-dental space. The portions of the gum which adheres to the neck of the tooth is of a very fibrous structure. At the necks of the teeth the gum is continuous with the periosteum of the inner surface of the alveoli, being reflected back upon itself, and uniting with the true peridental membrane. The gum of the upper jaw is supplied with vessels from the superior coronary artery, and that of the lower jaw from the submental and sublingual arteries. They derive their nerves from the superior dental branches of the fifth pair.

In the infant state of the gum, the central line of each dental arch presents a white, firm, cartilaginous ridge, which gradually becomes thinner as the teeth advance; and in old age, after the teeth drop out, the gum again resumes somewhat its former infantile condition, showing "second childhood."

The gum, being endowed with a high degree of vascularity, indicates very correctly, as the author has stated in another part of this work, the state of the constitutional health.

THE ALVEOLO-DENTAL PERIOSTEUM.

The dental periosteum lines the *alveolar cavities* or sockets of the teeth, covers the roots of each, is attached to the gums at the necks, and to the blood-vessels and nerves where they enter the roots of the teeth at their apices; and, further, Mr. Thomas Bell believes it passes into the cavities of the teeth, forming their lining membrane, and is continuous with or the same as that of the pulp.

Mr. Charles Tomes, in describing this membrane, says: "It is thicker near to the neck of the tooth, where it passes by imperceptible gradations into the gum and periosteum of the alveolar process, and near to the apex of the root. The general direction of the fibres is transverse—that is to say, they run across from the alveolus to the cementum, without break of continuity, as do also many capillary vessels; a mere inspection of the connective-tissue bundles, as seen in a transverse section of a decalcified tooth in its socket, will suffice to demonstrate that there is but a single 'membrane,' and

that no such thing as a membrane proper to the root and another proper to the alveolus can be distinguished; and the study of its development alike proves that the soft tissue investing the root and that lining the socket are one and the same thing; that there is but one 'membrane,' namely, the alveolo-dental periosteum. At that part which is nearest to the bone the fibres are grouped together into conspicuous bundles; it is, in fact, much like any ordinary fibrous membrane. On its inner aspect, where it becomes continuous with the cementum, it consists of a fine network of interlacing bands, many of which lose themselves in the surface of the cementum. But although there is a marked difference in histological character between the extreme parts of the membrane, yet the markedly fibrous elements of the outer blend and pass insensibly into the bands of the fine network of the inner part, and there is no break of continuity whatever. At the surface of the cementum it is more richly cellular, and here occur abundantly large, soft, nucleated plasm masses, which are the osteoblasts concerned in making cementum, and which, by their offshoots, communicate with plasm masses imprisoned within the cementum." According to Wedl, the vascular supply of the dental periosteum is derived from the gums, the vessels of the bone, and the vessels destined for the pulp of the tooth, the last being the most important. The nerves supplying the dental periosteum are derived from the dental pulp and from the nerves of the bone; hence it is apparent that the relationship between the pulp and periosteum of the teeth is very intimate.

ANATOMICAL RELATIONS OF THE MOUTH.

The mouth has many interesting anatomical relations with the rest of the body, a few of which it may be well to mention.

By means of its lining mucous membrane it is connected, through continuity of structure, with the pharynx, œsophagus, stomach and the whole of the intestinal canal, etc.

Disease still further establishes this structural relation. Inflammation, ulceration, or any other pathological change in the stomach or intestines, is felt and reported on the tongue, gums and other parts of the mouth, showing the sympathy and the close relationship of these several parts.

The mouth is also connected by the same mucous membrane with the organs of respiration, by being continued down into the larynx, trachea and bronchi.

Widespread sympathies are established between the mouth and other parts by means of the numerous nerves which animate the

parts constituting its boundaries and lying in its cavity, as the sympathetic, the seventh, the glosso-pharyngeal, the par vagum, the hypoglossal, and upper cervical.

Simple irritation from teething has thrown children into convulsions, and in adults toothache often creates extreme irritability of the whole nervous system. But it is not necessary to dwell here on the sympathies of the mouth in disease with other parts of the body, as the author will have occasion to do this in other parts of this work.

It will be well, however, to mention in this place that there is a general anatomical relation of the mouth with the rest of the body, by means of the blood-vessels and areolar tissue.

PHYSIOLOGICAL RELATIONS OF THE MOUTH.

It has been shown that the mouth consists of a great variety of parts, and, also, that it has an equally great diversity of functions.

The functions of the mouth have been stated to be those of prehension, mastication, insalivation and deglutition.

These functions, it has been seen, are all closely related to one another and mutually dependent; and how beautiful is the harmony of action as well as its regular and orderly succession! We see, in the first place, the prehensile instruments laying hold of and introducing the food into the mouth; then the organs of mastication, the teeth and upper and lower jaw bones, put into operation by the temporal, masseter and pterygoid muscles, grind it down into minute portions; these, at the same time, are formed into a bolus by being mixed with the salivary fluids furnished by the parotid, submaxillary and sublingual glands; then the mass is taken by the organs of deglutition, namely, the tongue, palate and pharynx, and passed into the œsophagus, to be thence conducted into the stomach, thus demonstrating the harmony existing among the several functions belonging to the mouth.

But the functional relation of the mouth is no less extensive than its structural relation; the one is commensurate with the other; and as the structure of the mouth has been shown to be continuous with that of other parts of the body, so we find that the functions of the mouth exert an influence upon, and are themselves influenced by, many great and leading functions of the body. The connection between mastication and insalivation, for example, with stomachal digestion, or chymification, is especially obvious.

Again, the mouth is intimately related with the intellectual functions, as, for instance, that of speech. Who does not know that

when any of the teeth are wanting, the palate cleft, or there is a hare-lip, how much the speech is impaired? And so with all the other functions of the body; the relations between them and the mouth, and the mutual dependence of each on the other, is equally demonstrable.

CHAPTER IX.

THE TEETH.

THE teeth in the human mouth are the prime organs of mastication, are the hardest portion of the body, and are implanted in the alveolar cavities of both the upper and lower jaw.

A tooth is composed of four distinct structures: 1. The *pulp*, occupying the chamber in the crown and the canal extending through the root; 2. The *dentine*, which constitutes the principal part of the organ; 3. The *enamel*, which forms the covering and protection of the crown; 5. The *cementum*, or *crusta petrosa*, which covers the root. (See Fig. 30.)

Two sets of teeth are developed in the mouth, one of first dentition and one of second dentition.

The teeth of first dentition, termed the milk, temporary, or deciduous teeth, are designed merely to supply the wants of childhood, and are replaced with a larger, stronger and more numerous set. The teeth of second dentition are termed the permanent or adult teeth, and are intended to continue through life.

The anatomical divisions of a tooth are: 1. The crown or exposed part, situated above the gum; 2. The root, occupying the alveolar cavity or socket; 3. The neck, which is the constricted portion between the crown and root.

FIG. 30.

a, the coronal surface divested of enamel; *b*, the dentine; *c*, the pulp cavity; *d*, the cementum, or crusta petrosa; *e*, the enamel.

THE TEMPORARY TEETH.

The temporary teeth are divided into three classes: first, the incisors; second, the cuspids, or canine teeth; third, the molars, which

are succeeded by the bicuspids or premolars, which are not represented in the temporary set.

The temporary teeth are twenty in number, ten in each jaw, namely: four incisors, two cuspids, and four molars.

Fig. 31.

FRONT OR LABIAL VIEW OF THE TEMPORARY TEETH OF THE LEFT SIDE.

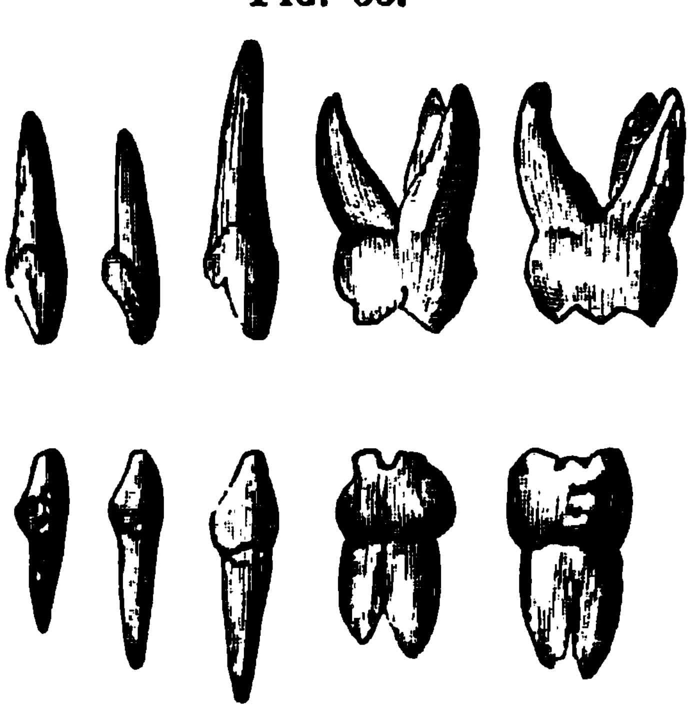
Fig. 32.

PALATINE AND LINGUAL VIEW OF THOSE ON THE RIGHT SIDE.

The incisors of the upper jaw are implanted in the pre-maxillary bones, which early in life unite with the maxillaries.

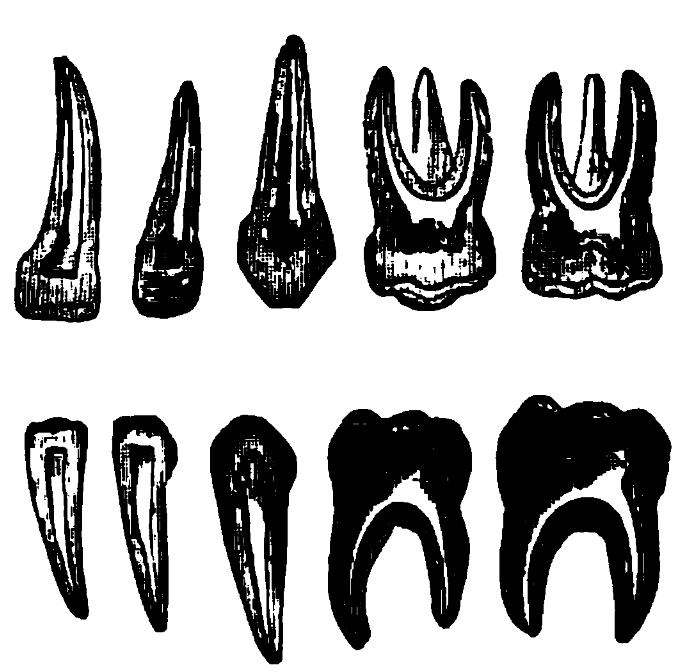
The pulp-cavity in a temporary tooth is also larger in proportion to the size of the organ than in a permanent tooth. The pulp-cavities

Fig. 33.



LATERAL OR SIDE VIEW OF TEMPORARY TEETH.

Fig. 34.



SECTION OF DITTO, EXPOSING THEIR PULP CAVITIES.

of the central and lateral incisors are of the same general shape, like that of an elongated tube, while those of the canines and molars correspond with the form of these teeth.

THE PERMANENT TEETH.

There are thirty-two teeth in the permanent set, sixteen to each jaw—being an increase of twelve over the temporary, designated as follows: incisors, four; cuspids, two; bicuspids or premolars, four; molars, six—in each jaw. The surfaces of the teeth covered by the lips are called "labial;" by the cheeks, "buccal;" toward the roof of the mouth on the upper jaw, "palatal;" toward the tongue on the lower jaw, "lingual." The name "proximate" is given to the surfaces next to each other; the surfaces looking toward the centre are called "mesial;" and those looking from the centre, "distal."

DESCRIPTION OF TEETH BELONGING TO EACH CLASS.

Each tooth, as has already been remarked, has a body or crown, a neck, and a root or fang. In describing these several parts, I shall begin with

The *Incisors* (four to each jaw, and so called from the Latin word *incidere*, to cut; on account of their sharp, cutting edges (Fig. 35),

Fig. 35.

a a, *a a*, front view of the incisors; *b b*, *b b*, palatine or lingual view; *c c*, *c c*, side or lateral view.

a a, *a a*). They occupy the anterior central part of each maxillary arch. The body of each is wedge shape—the anterior or labial surface is convex and smooth; the posterior or palatal is concave, and presents a tubercle near the neck; the palatal or labial surfaces come

together, and form a cutting edge. In a front view, the edge is generally the widest part; it diminishes toward the neck, and continues narrowing to the extremity of the root.

The crown of an incisor has four surfaces; two *proximate*, one *labial*, and one *palatal* or *lingual*—the term *palatal* being applied to an upper, and *lingual* to a lower, incisor. It also has four angles; namely, a *right* and a *left labio-proximate*, and a *right* and *left palato-proximate*, or *lingua-proximate.*

The two large incisors which are situated one on each side of the median line are termed the central incisors; the other two, the lateral incisors, or laterals, because they occupy a position on either side of the centrals. The crowns of the upper central incisors are about four lines in breadth, and the laterals three. In the lower jaw, the crowns of the central incisors are only about two lines and a half in width, while the laterals are usually a little wider. But the width of the crowns of all the incisors varies in different individuals.

The length of a superior central incisor is usually about one inch, and that of a lateral is half of a line less. In the lower jaw the central incisors are only about ten lines in length; the laterals are about one line and a half longer.

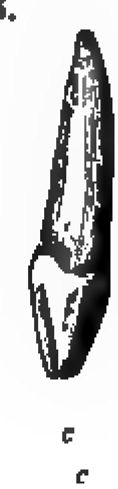
The length of the crown of an incisor is exceedingly variable. That of an upper central varies from four and a half to six lines; and there is the same want of uniformity in this respect with the crowns of all the incisors.

The superior central incisors are somewhat more prominent than the lateral incisors, owing to the curve of the alveolar process. The newly-erupted incisors have three points or cusps on their cutting edges, which soon disappear through wear, leaving such edges smooth and uniform. The labial aspect of the crown of a superior central incisor is convex, and the vertical diameter is greater than the transverse. Of the lateral surfaces, the mesial is generally flat, while the distal is more rounded. The lateral incisors are more slender in shape and smaller than the central incisors, but have the same general form, with somewhat more convexity of the labial surface.

The roots are all single, of a conical form, flattened laterally, and slightly furrowed longitudinally. Those of the lateral incisors are more flattened laterally than the roots of the centrals, slightly longer, and more gradually tapering towards the apex. The pulp-cavities of all the incisors have the same shape—like that of an elongated tube. The enamel is thicker before than behind, and thinnest at the sides.

The function of this class of teeth, as their name imports, is to cut the food, and for the performance of this office they are admirably fitted by their shape. As age advances, their edges often become blunted; but the rapidity with which they are worn away depends altogether upon the manner in which those of the upper and lower jaw come together.

FIG. 36.



a a, front view of the cuspids; *b b*, palatine and lingual view; *c c*, side view.

THE CUSPIDATI, OR CUSPIDS.

The *Cuspidati*, *Canini*, or *Cuspids*, so called from the Latin word *cuspis*, "a point," because they terminate in a point, are commonly known by the name of canines (Fig. 36). They are situated next to the incisors, and occupy the space between the lateral incisor and first bicuspid, two to each jaw, one on either side. They somewhat resemble the upper central incisors with their angles rounded. Their crowns are conical, very convex externally, and their palatal surface more uneven, and they have a larger tubercle than the incisors. They are stronger and generally more durable teeth than the incisors, and their roots form a vertical ridge on the external surface of the alveolar process. Their roots are also larger, and of all the teeth the longest; like the incisors, they are also single, but have a groove extending from the neck to the extremity, showing a step toward the formation of two roots. A cuspid, like an incisor, has four surfaces and four angles, designated by the names already given.

The breadth of the crown of an upper cuspid is about four lines, that of a lower is about three and a half; but, as in the case of the incisors, the width of the crowns of these teeth is variable. The length of a cuspid is greater than that of any other tooth in the dental series—it being about thirteen lines. The breadth of the neck of one these teeth is about one-third greater in front than behind, and from before backward it measures about four lines.

The upper cuspids, with no good reason, are sometimes called eye teeth; the lower are termed stomach teeth.

The inferior cuspids have a shorter root than the superior cuspids, and the median cusp is not so pointed.

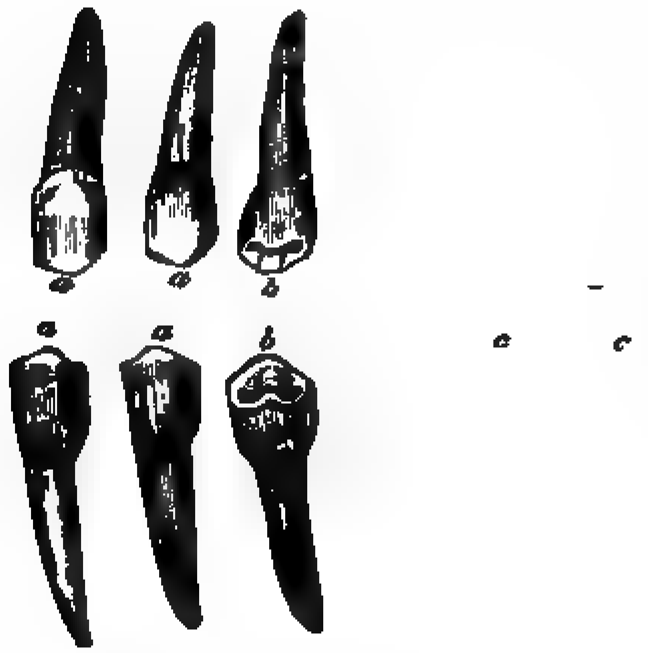
These teeth are for tearing the food, and in some of the carnivorous animals, where they are very large, they not only rend but also hold their prey.

The incisors and cuspids together are termed the *oral* teeth.

THE BICUSPIDS.

The *Bicuspids*, so called from the Latin words *bis*, "twice," and *cuspis*, "a point" (Fig. 37), four to each jaw and two on either side, are next in order to the cuspids. They have two distinct prominences or cusps on their grinding surfaces, one external and the other internal, and separated by a deep depression or notch. In the superior bicuspids the external cusp is somewhat larger than the internal cusp, while in the inferior bicuspids the internal cusp is larger than the external, and the root is more cylindrical in form. They are also named premolars or the small molars, but are more commonly designated as the first and second bicuspids. They are thicker from their buccal to their palatine surface than either of the incisors, and are flatter on their sides. The buccal surfaces are very convex, and the crowns of the second bicuspids are generally somewhat larger than those of the first bicuspids, and more of a square form.

FIG. 37.



a a, a a, buccal view of the bicuspids; *b b, b b*, palatine and lingual view; *c c, c c*, side view.

A biscuspid has five surfaces: namely, two *proximate*, one *anterior* and one *posterior*; one *buccal*; one *palatal* or *lingual* surface, as the tooth may be in the upper or lower jaw, and one *grinding* surface. It has four angles; one *anterior* and one *posterior paluto-proximate* and one *anterior* and one *posterior bucco-proximate* angle.

The size of these teeth, like that of the incisors and cuspids, is variable. The buccal surface of the crown of a superior bicuspid of ordinary size at its broadest part is about three lines in breadth, while the anterior and posterior proximal surfaces are about four lines. The palatal is quite as wide as the buccal surface. All the diameters of the crown of a lower bicuspid are usually a little less than those of an upper. The entire length of a bicuspid is ordinarily about eleven lines.

The superior bicuspids have generally two roots, but sometimes a single root, which is often deeply grooved, while the inferior bicuspids have but one root. The deeply-grooved root is indicative of

two pulp-cavities, which may unite at the central portion of the root and form a narrow transverse fissure at the neck of the tooth. Of the two roots of the superior bicuspids, the inner or palatal is smaller than the outer or buccal, each root having an opening for the vessels and nerves to enter.

THE MOLARS.

The *Molars*, so called from the Latin word *molaris*, "grinding," and designated as first, second, and third molars (Fig. 38), occupy the posterior part of the alveolar arch, and are six in each jaw, three on

FIG. 38.

a a a, *a a a*, outer view of the molars; *b b b*, *b b b*, inner view; *c c c*, *c c c*, side view.

either side. The first, owing to the period of their eruption, are called the sixth-year molars, and the second, for the same reason, are called the twelfth-year molars, while the third are called the dentes

sapientiæ or wisdom teeth, from the Latin word *dens*, "a tooth," and *sapientia*, "wisdom," being erupted at a period when maturity is reached. The molars are distinguished by their greater size—the first and second being the largest; the grinding surfaces have the enamel thicker, and are surmounted by four or five tubercles or cusps, with as many corresponding depressions arranged in such a manner that the tubercles of the upper jaw are adapted to the depressions of the lower, and *vice versa*.

A molar, like a bicuspid, has also five surfaces and five angles, designated by the names already given.

The upper molars have three roots, sometimes four, and as many as five are occasionally seen; of these roots two are situated externally, almost parallel with each other, and perpendicular; the third root forms an acute angle, and looks toward the roof of the mouth. The former are called the *buccal* roots, and the latter the *palatal*. The roots of the first two superior molars correspond with the floor of the maxillary sinus, and sometimes protrude into this cavity, their divergence securing them more firmly in their sockets. The lower molars have but two roots—the one anterior, the other posterior; they are nearly vertical, parallel with each other, and much flattened laterally.

The last molar, or wisdom tooth, is both shorter and smaller than the others; the roots of the upper wisdom tooth are, occasionally, united so as to form but one; while the last molar of the lower jaw is generally single and of a conical form.

The roots of the molar teeth, both of the upper and lower jaw, after diverging, sometimes approach each other, embracing the intervening bony partition in such a manner as to constitute an obstacle to their extraction.

The bucco-palatal diameter of the crown of an upper molar is usually a little less than the antero-posterior. In the lower jaw, the bucco-lingual and antero-posterior diameters are generally about the same.

The crown of the first molar is generally larger than the second, and the second larger than the third or wisdom tooth; and the crown of the last-named tooth is always smaller in the upper than in the lower jaw.

The pulp-cavities correspond to the external form of the roots, and at the necks of these teeth they unite into a common cavity called the pulp-chamber, which often ends in cornua corresponding to the cusps.

The length of a molar tooth varies from eight to twelve and a half or thirteen lines.

The molars and bicuspids together constitute what are termed the buccal teeth.

The use of the molars, as their name signifies, is to triturate or grind the food during mastication, and for this purpose they are admirably adapted by their mechanical arrangement.

ARTICULATION OF THE TEETH.

The manner in which the teeth are confined in their sockets is by a union called *gomphosis*, from the resemblance of this kind of articulation to the way in which a nail is received into a board. Those teeth having but one root, and those with two perpendicular roots, depend greatly, for the strength of their articulation, on their nice adaptation to their sockets.

Those having three or four roots have their firmness much increased by their divergence.

But there are other bonds of union; by the periosteum lining the alveolar cavities, and investing the roots of the teeth; also by the blood-vessels entering the apices of the roots; and finally, by the gums, which will be noticed in another place.

DIFFERENCES BETWEEN THE TEMPORARY AND PERMANENT TEETH.

The temporary and permanent teeth differ in several respects, and on this point I will give Mr. Bell's observations:—

"The temporary teeth are, generally speaking, much smaller than the permanent; of a less firm and solid texture, and their characteristic forms and prominences much less strongly marked. The incisors and cuspids of the lower jaw are of the same general form as in the adult, though much smaller; the edges are more rounded, and they are not much more than half the length of the latter. The molars of the child, on the contrary, are considerably larger than the bicuspids which succeed them, and resemble very nearly the permanent molars.

"The roots of the tooth in the molars of the child are similar in number to those of the adult molars, but they are flatter and thinner in proportion, more hollowed on their inner surfaces, and diverge from the neck at a more abrupt angle, forming a sort of arch."

In the temporary teeth the union of the enamel and cementum is distinctly marked by a well-defined ridge of enamel at the base of the crown, which forms a constricted neck; whereas in the permanent teeth the union of the enamel and cementum at the base of the crown is very indistinct.

RELATIONS OF THE TEETH OF THE UPPER TO THOSE OF THE LOWER JAW, WHEN THE MOUTH IS CLOSED.

The crowns of the teeth of the upper jaw generally describe a rather larger arch than those of the lower. The upper incisors and cuspids usually shut over and in front of the lower; but sometimes they fall plumb upon them, and at other times, though rarely, they come on the inside. The external tubercles or cusps of the superior bicuspids and molars generally strike on the outside of those of the corresponding inferior teeth. By this beautiful adaptation of the tubercles of the teeth of one jaw to the depressions of those of the other, every part of the grinding surface of these organs is brought into immediate contact in the act of mastication; which operation of the teeth, in consequence, is rendered more perfect than it would be if the organs came together in any other manner.

The incisors and cuspids of the upper jaw are broader than the corresponding teeth in the lower; in consequence of this difference in the lateral diameter of the teeth of the two jaws, the central incisors of the upper cover the centrals and about half of the laterals in the lower, while the superior laterals cover the remaining half of the inferior and the anterior half of the adjoining cuspids. Continuing this peculiar relationship, the upper cuspids close over the remaining half of the lower and the anterior half of the first inferior bicuspids, while the first superior bicuspids cover the remaining half of the first inferior and the anterior half of the second. In like manner, the second bicuspids of the upper jaw close over the posterior half of the second and the anterior third of the first molars in the lower. The first superior molars cover the remaining two-thirds of the first inferior and the anterior third of the second, while the two-thirds of this last and anterior third of the lower dentes sapientiæ are covered by the second upper molars. The dentes sapientiæ of the superior maxilla, being usually about one-third less in their antero-posterior diameter, cover the remaining two-thirds of the corresponding teeth in the lower jaw. (See Fig. 39.)

Fig. 39.

Thus, from this arrangement of the teeth, it will be seen that

when the mouth is closed each tooth is opposed to two; and hence, in biting hard substances and in mastication, by extending this mutual aid, a power of resistance is given to these organs which they would not otherwise possess. Moreover, as an English writer, Mr. Tomes, very justly observes, if one, or even two adjoining teeth should be lost, the corresponding teeth in the other jaw would, to some extent, still act against the contiguous organs, and thus, in some degree, counteract a process, first noticed by that eminent dentist, Dr. L. Koecker, which nature sometimes sets up for the expulsion of such teeth as have lost their antagonists.

CHAPTER X.

MALFORMED TEETH.

PECULIARITIES *in the Formation and Growth of the Teeth.*—In the development and growth of the various parts of the body, curious and interesting anomalies are sometimes observed; but in no portion of it are they more frequent in their occurrence or diversified

FIG. 40.

FIG. 41.

FIG. 40 shows the front view of the lateral incisor and canine from the left side of the under jaw, united throughout their entire length, but with the line of junction well marked. The age at which they were removed was seven years. The corresponding teeth on the opposite side of the jaw were similarly united.

FIG. 41 shows the representation of the lateral incisor and canine from the left side of the lower jaw of a patient aged nine years. In this example the line of junction is less distinctly marked than in the preceding illustration, and is altogether wanting near the base of the enamel.

in their character than in the teeth. But aberrations in the formation and growth of these organs are, for the most part, confined to the teeth of second dentition.

Although the deciduous teeth are much more exempt from deviations in form, size and number, than the permanent teeth, yet they are not altogether free from such irregularities. One form of irregularity of these teeth may consist in a greater number than twenty; while in other cases there may be a numerical deficiency. Deciduous teeth, especially the molars, are occasionally met with

having more than the normal number of roots. A more common form of irregularity is the union of two, or sometimes even three, deciduous teeth, generally incisors, or an incisor and a canine, either by a union in the cementum, or in the dentine and enamel. When the union is in the cementum, the roots only are united, but where it is in the dentine and enamel there is a fusion of both the crowns and the roots, and one pulp common to the two teeth (geminous).

Fig. 42^1 represents two specimens of triple fusion of the deciduous right superior lateral incisor and cuspid, with a supernumerary tooth between the two, taken from the mouth of a boy three years of age. Fig. 42^2 represents another specimen of triple fusion of deciduous teeth from the mouth of a little girl, which occupied the same position as that represented by Fig. 42^1, and was composed of the same teeth. Both of these specimens were extracted by Dr. Isaac Douglass.

Malformed Permanent Teeth.—Irregularity in the forms of permanent teeth is much more common than is the case with deciduous teeth; some of the former differing so much in size, either above or below what is normal, as to occasion disfigurement; in the same mouth very large teeth may be associated with others ex-

Fig. 42.

Fig. 43.

Fig. 44.

tremely small, or the malformation may be confined to a single tooth of the set. But examples of this kind are not very frequent; for where there is an increase or diminution in the size of the teeth of one class, there is generally a corresponding change in that of the other.

Aberrations of this character are probably dependent upon some diathesis of the general system, whereby the teeth, during the earlier stages of their formation, are supplied with an excessive or diminished quantity of nutriment. Again, the malformation may be confined to the root, while the crown of the tooth is of the normal size.

A superior central incisor may have a root which is abnormally small, while the crown is of the usual size.

Another malformation consists in an excess of the normal number of roots, the superior molars sometimes having four or six slender

roots, and the inferior molars three and four, the inferior canines two, and the superior bicuspids three roots. Figs. 43, 44. The varia-

Fig. 45.

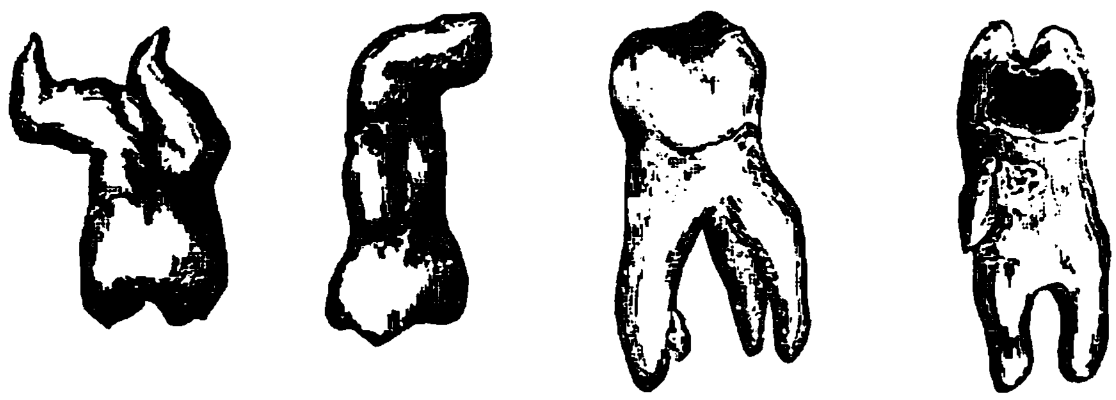


Fig. 46.

tions in form of the permanent teeth are beyond enumeration; in some cases teeth with single roots are bent at different angles. The crowns of the teeth, also, frequently present deviations from the natural shape equally striking and remarkable.

Figs. 45, 46 and 47 represent molar and incisor teeth with malformed roots.

Teeth with flexed roots are also met with. Figs. 48 and 49 represent superior central incisors with single and double flexions of the roots.

Fig. 47.

Fig. 48.

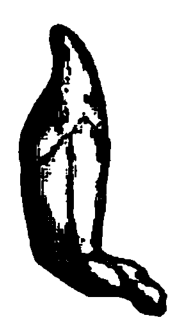
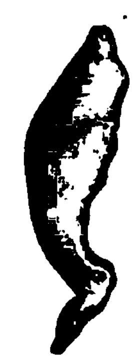


Fig. 49.



Mr. Fox gives a drawing of a tooth very much resembling the letter S. The author has also met with several examples of teeth similarly deformed, and from like causes.

Some very remarkable deviations have been known to take place in the growth of the teeth. The most singular case on record is that related by Albinus. "Two teeth," says he, "between the nose and the orbits of the eye, one on the right side and the other on the left, were inclosed in the roots of those processes that extend from the maxillary bones to the eminence of the nose. They were large, remarkably thick, and so very like the canines that they seemed to be these teeth, which had not before appeared; but the canines themselves were also present, more than usually small and short, and placed in their proper sockets. The former, therefore, appear to have been new canines, which had not penetrated their sockets, because they were situated where these same teeth are usually observed to be in children. But what is still more remarkable, their points were directed towards the eyes, as if they were the new eye

teeth inverted. And they were also so formed that they were, contrary to what usually happens, convex on the posterior and concave on the anterior." A case of a somewhat similar character is mentioned by Mr. John Hunter.

The following case is in the words of Mr. G. Wait: "While I was prosecuting my anatomical studies, I was struck with the appearance of a cuspid of the upper jaw; it was short, and appeared as if the body of the tooth was in the jaw, and that it was the tip of the root that presented itself. Upon further examination I found this verified, and after the cranium and lower jaw were properly macerated and cleansed, I found one of the lower bicuspids in the same position."

The following is one of the several cases of deviation in the growth of the teeth that have come under the author's observation: In 1840, he was requested to extract a tooth for a lady of Baltimore under the following circumstances. She had, for a time, experienced a great deal of pain in her upper jaw, and supposed it to originate from the second molar of the right side, but which was perfectly sound. Meanwhile her general health became impaired, and her attending physician, thinking that the local irritation might have contributed to her debility, advised the extraction of the tooth. On removing it, the cause of the pain at once became apparent. The dens sapientiæ, which had not hitherto appeared, was discovered with its roots extending back to the utmost verge of the angle of the jaw, while its grinding surface had been in contact with the posterior surface of the crown and neck of the tooth just extracted. On the removal of the wisdom tooth the pain ceased.

About the middle of December, 1849, a youth aged sixteen applied to the author to extract a right superior bicuspid, which, he said, was ulcerated at the root. On examining his mouth, he discovered only one bicuspid, but above and between the root of this and that of the first molar, he observed a small fistulous opening. On introducing a small probe, it immediately came in contact with the crown of a tooth looking toward the malar process of the superior maxillary, which, on extraction, proved to be the second bicuspid.

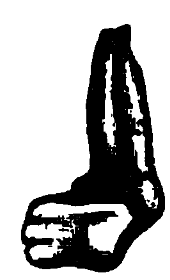
The author has in his possession several molar and bicuspid teeth which have small nodes upon their necks, covered with enamel; and there is a jaw in the Museum of the Baltimore Dental College which has five teeth presenting this anomaly.

The author has two teeth in his possession of most singular shape, presented to him by his brother, the late Dr. John Harris. They were extracted in July, 1822, from the right side of the upper jaw of a young gentleman, nineteen years of age, by the name of Crawford. They occupied the place of the first and second bicuspids

and their crowns are almost wholly imbedded in lamellated dentine, that should have constituted their roots, but which are entirely wanting. Judging from their appearance, one would be inclined to suppose that, their sacs failing to contract, they remained stationary in their sockets, and as the base of the pulps elongated, they came in contact with the bottom of the alveoli, and were caused to bulge out and to be reflected upon their crowns, to the enamel of which, nearly to their grinding surfaces, they are perfectly united. For some time previously to the extraction of these teeth, they had been productive of considerable irritation and pain in the gums and jaw, and it was for the relief of the suffering which their presence induced that they were removed.

Since the above was written, the author has seen a still more remarkable deviation in the growth of a tooth. It is in the upper jaw of an adult skull in which the natural teeth are all well formed and regularly arranged in the alveolar border, but between the extremities of the roots of the superior central incisors, in the substance of the jaw, there is a supernumerary tooth the crown of which looks upward toward the crest of the nasal plates of the two bones. The whole tooth is about one inch in length, and the apex of the crown is nearly on a level with the floor of the nasal cavities. There is also in the Dental Museum of the University of Maryland a central incisor of the upper jaw, with the root bent upon, and in contact with, the labial surface of the crown (Fig. 50).

FIG. 50.



United Teeth.—Inclosed as each tooth is in a distinct sac, and separated on either side by a bony partition from the adjoining teeth, until after the completion of the formation of the enamel, it may be difficult to conceive how osseous union could take place between two of these organs, but so many examples of such union are met with, that there is no longer any question concerning its possibility.

Two or more teeth, generally the molars, may be permanently joined together by a union in the cementum of their roots, occasioned by diseased action, such as exostosis, taking place after the complete development of the teeth. The term "osseous union" has been applied to such cases.

Fig. 51 represents united second and third molars, the one figure presenting the buccal aspect, and the other the palatal.

Fig. 52 also represents the osseous union of superior second and third molars.

Many years ago we had an opportunity of seeing two interesting cases. One consisted in the union of the crowns of the central

incisors of the upper jaw, the palatine surface of which presented the appearance of one broad tooth, while anteriorly they had the semblance of two teeth; the other case consisted in the union of the right central and lateral incisors of the lower jaw.

A professional friend informed the author, in a conversation some years since, that he had met with a case of osseous union between a second bicuspid and the first molar of the lower jaw, which was so palpable that there could have been no doubt of its existence.

Cases of this nature are not very common, and a connection of the roots of two teeth, by an intervening portion of the alveolus, is very

FIG. 51. FIG. 52.

easily mistaken for osseous union of the roots themselves. A few years since, in extracting a second molar of the upper jaw, the author brought the dens sapientiæ along with it. At first he thought there was osseous union of the roots, but upon close examination found a very thin portion of the alveolar wall between, to which their roots were firmly attached. Such a case as this would, in many instances, be set down as an example of osseous union.

An osseous union of the teeth is, fortunately, of rare occurrence; if it were otherwise, it would be productive of many accidents in the extraction of teeth. Apart from this consideration, it can be of but little importance either to the practitioner or to the physiologist.

Since the publication of the first edition of this work, a number of cases of osseous union of the teeth have fallen under the observation of the author. Among them are a number of examples of osseous union of the temporary teeth.

Geminous or Fused Teeth.—When two teeth are united by a union in the enamel and dentine throughout the entire length of their crowns and roots, they are termed "geminous" or "fused" teeth, as the malformation is occasioned by a fusion of their pulp, from close proximity and pressure, one pulp being common to the two teeth. The two central incisors and the lateral incisors and canines are more commonly joined together in this manner than any of the other teeth. Fig. 53 represents geminous central and lateral in-

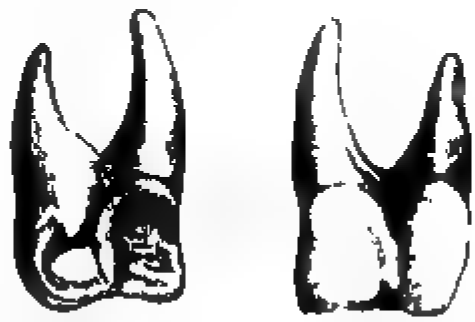
cisors, showing the labial and palatal aspects, these specimens being in the Dental Museum of the University of Maryland.

Other cases occur where the union or fusion is confined to the crowns of the teeth, the roots being separate.

Fig. 54 represents two geminous central incisors, the crowns of which are united while the roots are separate.

FIG. 53.

FIG. 54.



Supernumerary Teeth.—The development of supernumerary teeth is usually confined to the anterior part of the mouth, and more frequently to the upper than to the lower jaw. They sometimes, however, appear as far back as the dentes sapientiæ, and Hudson says he has seen them behind these teeth. We have now in our anatomical collection two supernumerary teeth that were extracted, one from behind and the other at the side of one of the upper wisdom teeth.*

The crowns of supernumerary teeth which appear in the anterior part of the mouth are usually of a conical shape, and for the most part situated between the central incisors; they usually have short, knotty roots; sometimes, however, they bear so strong a resemblance to the other teeth that it is difficult to distinguish the one from the other. We once saw two lateral incisors in the lower jaw, both of which were so well arranged and perfectly formed that it was impossible to determine which of the two ought to be considered as the supernumerary. Mr. Bell mentions a case in which there were five lower incisors, all of which were well formed and regularly arranged. Such teeth, however, are more properly known as "supplemental."

Supernumerary cuspids rarely if ever occur, but supernumerary bicuspids are occasionally met with. Delabarre says he has seen them; and we have met with three examples of the sort; in each of these instances the teeth were very small, not being more than one-fourth as large as the natural bicuspids, with oval crowns, and placed partly on the outside of the circle and partly between the bicuspids. We extracted one of them, and have it still in our possession. Its root is short, round, and nearly as thick at its extremity as it is at the neck of the tooth.

* These teeth were removed by Dr. Chewning, dentist, of Fredericksburg, Va.

The supernumerary teeth that appear further back than the bicuspids, though much smaller, bear a strong resemblance to the dentes sapientiæ.

Supernumerary teeth, although generally imperfect in their formation, are less liable than other teeth to decay. This may be attributable to the fact that they are harder, and, consequently, not so susceptible to the action of the causes that produce the disease.

Although the occurrence of supernumerary teeth rarely disturbs the arrangement of the others, their presence is sometimes productive of the worst form of irregularity (Fig. 55 represents a case of this kind);

Fig. 55.

and even when they do not have this effect, they impair the beauty of the mouth, and, for this reason, should be extracted as soon as their crowns have completely emerged from the gums.

To the practitioner of dental surgery, the occurrence of supernumerary teeth is interesting only in so far as it affects the beauty of the mouth and the relationship which the teeth of the upper jaw sustain to those of the lower; but to the physiologist it involves the question, what determines their development? In propounding this interrogatory, however, it is not our intention to enter upon its discussion in this place, as it forms no part of the design of the present treatise. (See "Origin of Permanent Teeth.")

Supplemental Teeth.—The term supplemental is employed to designate teeth which resemble in shape and size those of the regular series, as a third lateral incisor or canine, or a fifth bicuspid, in either the upper or lower jaw, the additional teeth being perfectly normal in form. Such teeth are extremely rare, but we have met with several examples in which supplemental teeth so closely resembled the natural incisors that no difference could be discerned between them. We have also met with three superior lateral incisors where it was impossible to determine which was the supplemental tooth.

Nodular Teeth.—Occasionally teeth are found having small, white, pearly nodules on their necks, or upon the roots near the termination of the enamel. These enamel nodules consist of a thick layer

of enamel covering a cone of dentine, which projects from the neck or root of the tooth, and contains dentinal tubuli. They are similar to the excrescences in the form of extra cusps, which are sometimes found on the crowns of the teeth, especially the molars, and the enamel covering them is formed by a true enamel organ. These nodules are of physiological interest only, as they do not give rise to any pathological symptoms. They are a variety of dental exostosis which is extremely rare and difficult to account for. Sometimes they may be mistaken for supernumerary teeth, and an attempt to remove them may result in the extraction of the tooth to which they are attached.

Fig. 56.

Fig. 57.

Fig. 58.

coated surface; b, nodules of enamel.

Figs. 56 and 57 represent permanent teeth with nodules of enamel attached to the necks and sides of the roots.

Odontomes.—This term has been generally applied to tooth tumors developed from the hard tissues of the teeth, but it is now restricted to those irregular masses of dentinal tissues which result from some hypertrophied condition of the tooth papilla or formative pulp. In such cases the irregular mass consists of dentine and enamel, bearing little or no resemblance to a tooth; and it originates after the commencement of calcification.

Fig. 58 represents an odontome consisting of an irregular mass of tooth tissues.

The teeth described by Salter, Wedl and others, under the name of "*Warty Teeth,*" and which are composed of tissues hypertrophied and folded together into an irregular and complicated mass, afford a fair example of odontomes.

It is not unusual for odontomes to remain in the mouth for a considerable time without causing trouble, but sooner or later they may give rise to inflammation followed by suppuration in the adjoining parts, when their immediate removal is necessary. Mr. John Tomes refers to a case where the body of the sphenoid bone was found to be the seat of a tumor containing dentine.

Figs. 59, 60 represent dental anomalies extracted from the mouth of

an old woman seventy years of age, one of the hairy Burmese family, by Dr. J. A. Daly, and are described as follows by Dr. C. T. Caldwell:—

"I find two very remarkable instances of gemination or organic union of two neighboring teeth. The measurements and outlines of the drawing are as near as possible correct. Figs. 59 and 60.

"The lines A B and C D are intended to show the position of the teeth in the jaw, the portions above A B and below C D indicating the parts exposed above the gum. They were covered by a thick layer of dark-brown concretion, the exact nature of which I have not determined.

"Fig 59 shows the right second molar and wisdom-tooth of the lower jaw so completely joined together that both crowns and roots are united throughout their entire length. The two roots of the second molar may be easily made out in the specimen, and just behind them, and completely fused with them, is the connate root of the wisdom-tooth.

Fig. 59. Fig. 60.

"Still more remarkable than this is the specimen represented by Fig. 60, wherein the union of two upper molars is confined to the roots, which are so welded or blended together as to leave but little trace of the several fangs. This specimen was at first supposed to be a large-sized molar with an enormous exostosis, but a section through the parts shown in the drawing disclosed a pulp-cavity, and close examination revealed the fact that this portion of the mass is in reality the crown of a tooth, made up of enamel, dentine, and pulp-cavity, filled with nerve and nutrient vessels, as in ordinary teeth. The tubercles or cusps, having never been subjected to wear, are in a perfect condition on what should have been the top or free surface of the crown, while the roots had become coalescent with those of its neighbor in such a manner that only one of the united teeth could assume an upright or natural position in the jaw, the other being forced into a horizontal position, with only a side protruding above the surface of the bone.

"This gemination or coalescence of contiguous teeth occurs during an early stage of their development, and is due to absorption of the

intervening bony tissue caused by pressure, where, as in this case, several very large teeth crowd themselves into a very small mouth."

Syphilitic Teeth.—Mr. J. Hutchinson was the first to call attention to a class of malformed permanent teeth, the result of inherited syphilis, and he asserts that certain deviations in the forms of teeth are valuable as diagnostic marks of the existence of syphilis of a congenital constitutional type, and he classes them with syphilitic interstitial keratitis. This author describes syphilitic teeth as follows: "In those who had cut their permanent teeth the condition of the incisor teeth was very peculiar, both in form, color and size. As a diagnostic of hereditary syphilis, various peculiarities are often presented by the others, especially the canines; but the upper central incisors are the test teeth. When first cut, these teeth are short, narrow from side to side at their edges, and very thin. After awhile a crescentic portion from their edge breaks away, leaving a broad, shallow, vertical notch, which is permanent for some years, but

FIG. 61.

FIG. 62.

A. B.

between twenty and thirty usually becomes obliterated by the premature wearing down of the teeth. The two teeth often converge, and sometimes they stand widely apart. In certain instances in which the notching is either wholly absent or but slightly marked, there is still a peculiar color and a narrow squareness of form, which are easily recognized by the practiced eye. . . . . . Indeed, there can be no doubt whatever as to the truth of the assertion that malformed upper incisors (permanent set) are all but invariably coincident with this disease."

Henry W. Williams, M. D., Professor of Ophthalmology in Harvard University, confirms Mr. Hutchinson's observations, and says: "The central incisors of the second dentition have a peculiar crescentic notch at their lower margins, and the lateral incisors and canines, as well as the molars, are often small, peg-shaped, and with

tuberculated prominences upon their surface. They are, perhaps, also irregularly set in the jaw, and of bad color, or prematurely decayed."

Figs. 61 and 62 represent syphilitic teeth in a boy and two girls, aged respectively twelve, fourteen and seventeen years.

Mr. John Tomes describes these teeth as being of "a dusky, opaque appearance, and are small relatively to the size of the jaws, so that distinct intervals are left between them; moreover, they are of a very soft character, so that they speedily become worn down, and the characteristic transverse notch obliterated." Mr. Hutchinson remarks: "Inasmuch as specific inflammations do not occur during the period of intra-uterine life, the teeth belonging to the deciduous series are not liable to be affected, though they may be lost by exfoliation consequent on stomatitis and periostitis. On the other hand, the occurrence of specific affections of the mouth soon after birth may be readily supposed to affect the permanent teeth which are at this time developing, and certain characters are enumerated as indicative of such interference with the growing teeth."

Deviations of the teeth from the normal condition are so numerous and varied in their character, that it would be impossible to describe all of them.

Under the title of "*dilaceration*," Mr. John Tomes describes a condition of tooth resulting from displacement of the calcified portion of a tooth from the tissues which were instrumental in its production, the development being continued after the normal position of the calcified portion was lost; for example, the crown of an incisor when partly formed may move from its position upon the pulp, and be turned outward or inward, or to either side, and there remain in a state of rest, the development of the tooth continuing with the displacement of one-half of the crown permanently preserved.

FIG. 63.

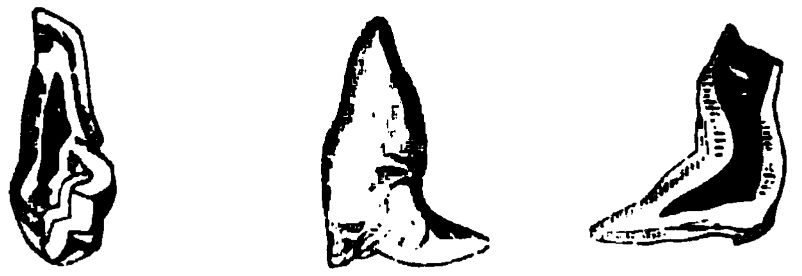


Fig. 63 represents three cases of dilaceration, two incisors and a bicuspid.

Teeth have also been found with the root at the apex expanded into a cup-shaped disk, on the margins of which are several openings or foramina for the entrance of the nerves and vessels. Also teeth with dentine excrescences in the form of nodules growing from the wall of the pulp chamber. Sometimes these nodules of secondary dentine almost fill the pulp-chamber, while the parenchyma of the pulp is extensively occupied by small

granules. Such excrescences frequently cause pain of a neuralgic character. The devitalization of the pulp is the only treatment.

Dilated roots of teeth are caused by the dentinal pulp becoming hypertrophied into a globular structure of considerable size, and when calcified forming an osseous mass, often larger than the tooth itself. Such tumors are composed of an outer layer of cementum, and a thin shell of dentine enclosing a voluminous pulp, which may or may not be calcified. Dilated roots of teeth may occasion pain when the jaws are opened, with expansion of the jaw at the alveolar portion.

Malformed teeth also result from interrupted development of the dental tissues, which is manifested by the crowns irregularly grooved or pitted and smaller than the natural size. The incisors are generally thin and atrophied, and the cusps of the canines and molars sharp-pointed, such teeth being deficient in quantity and quality of their tissues, and of a yellow, opaque color. Malformed teeth are sometimes, though rarely, met with where the roots are perfectly developed, while the crowns present a peculiar deficiency, and consist of rudimentary formations which appear like small irregular masses of dentine without any enamel covering. These crownless teeth, as they may be styled, are sometimes found worn level with the gum line.

Another anomaly of tooth-structure, and one that is also very rare, consists of teeth with crowns flattened in an antero-posterior direction, the jaws presenting an edentulous appearance. The sulci of such teeth are misshapen, and the cusps are like narrow ridges.

Exostosed teeth are also included in those that deviate from the normal form, one of the most remarkable instances of which was a case exhibited by Mr. Tomes—a molar of the upper jaw, removed from a patient aged forty-one, who had long suffered pain in the jaw, from which a fistulous passage led through the cheek. Fig. 64 represents this case. (See "Exostosis of the Teeth.")

FIG. 64.

Unerupted or Impacted Teeth are often malformed, and may cause dentigerous cysts. (See "Dentigerous Cysts.")

Organic Defects of Structure.—That peculiar structural defect of the teeth, which was formerly designated *atrophy*, is less frequent in its occurrence than any other disease to which these organs are liable; but as the progress of the affection usually terminates with the action of the causes concerned in its production, it has scarcely

been deemed of sufficient importance to merit serious consideration. Hence its etiology and pathology have not been very carefully investigated.

Fig. 65 represents superior and inferior front teeth with crowns disfigured by irregular grooves and pits.

This affection consists in a congenital defect of structure in teeth rather than in the wasting, for want of nourishment, of any of the dental tissues. The congenital form of the disease is evidently the result of altered function in a portion of one or more of the formative organs—if not of absolute degeneration, from vicious nutrition.

Fig. 65.

Teeth presenting these organic structural defects may very properly be divided into three varieties. Each has characteristic peculiarities which distinguish it from either of the others. Two are always congenital, and the other, although most frequently congenital, sometimes occurs subsequently to the eruption of the tooth.

First variety.—The peculiarities that distinguish this variety from either of the others are, that it never impairs the uniformity and smoothness of the surface of the enamel, and is characterized by one or more white, or dark, or light brown, irregularly shaped spots, upon the labial or buccal surface of the tooth. It occurs oftener than the third variety, and less frequently than the second. It rarely appears on more than one or two teeth in the same mouth, though several are sometimes marked by it. It is seen on the molars more frequently than the bicuspids, and much oftener on the incisors of the upper jaw than any of the other teeth. We do not

recollect to have ever observed it on the cuspids of either jaw, nor on the palatine or lingual surfaces of the incisors.

The enamel is much softer on the affected than on the unaffected parts of the tooth, and may be easily broken and reduced to powder with a steel instrument. It seems to be almost wholly deprived, in these places, of its animal constituents, and to have lost its connection with the subjacent dentine. The size of the defective spots is almost as variable as their shape, but the only harm resulting from them is the unsightly aspect they sometimes give to the tooth.

As we have before remarked, this variety is sometimes accidental, occurring subsequently to the eruption of the tooth, but in a large majority of cases it is congenital. It is rarely seen on a temporary tooth. In all the cases which have come under our observation, it was confined, to the best of our recollection, to the teeth of second dentition.

Second variety.—This may be very properly denominated *perforating* or *pitting* defect; it gives to the enamel an indented or pitted appearance, the irregular depressions or holes extending transversely across and around the tooth. The pits are sometimes more or less distinctly separated one from another by prominent lines; at other times they are confluent, and form an irregular horizontal groove. Sometimes they penetrate but a short distance into the enamel; at other times they extend entirely through it to the dentine. Their surface, though generally rough and irregular, usually presents a glossy and polished appearance—a peculiarity which always distinguishes this variety of the affection from erosion. The pits often have a dark-brownish appearance, though sometimes they have the same color as the enamel on other parts of the teeth.

This variety is never confined to a single tooth. Two, four, six or more corresponding teeth are always affected at the same time in each jaw; and the corresponding teeth on either side precisely in the same manner and in the same place. When more than two are marked, the distance of the pits from the coronal extremity of the tooth varies, according to the progress made in the formation of the enamel at the time of the operation of the causes concerned in the production of the affection. For example, when the line of pits in the central incisors is situated about two lines from their cutting edges, it will scarcely be one line from the cutting edges of the laterals, and only the points of the cuspids will be marked. When the indentations are nearer the edges of the central incisors, they will be on the edges of the laterals, and the cuspids will have entirely escaped.

Sometimes the teeth are marked with two or three rows of pits, and when this is the case, the patient has either two or three relapses; or has been attacked two or three times in succession with some disease capable of interrupting the progress of the formation of the enamel.

Although the incisors are more frequently marked with these indentations than any of the other teeth, the cuspids, bicuspids, and even the molars, are sometimes affected with them. When the disease attacks the molars, its effects are generally located on the grinding surface. The permanent teeth are more liable to be attacked than the temporary. We have known but one instance in which the latter were affected with the disease.

This variety occurs oftener than either of the others, and though it sometimes gives to the teeth a disagreeable and unsightly appearance, it rarely increases their liability to decay.

Third variety.—In this variety the whole or only a part of the crown of a tooth may be affected; the dentine being often implicated as well as the enamel. The tooth usually has a pale-yellowish color, a shrivelled appearance, and is partially or wholly divested of enamel. Sometimes the crown is not more than one-half or one-third its natural size. Its sensibility is usually much increased, and its susceptibility to pain from external impressions is wonderfully excited by acids. It is also more liable than the other teeth to be attacked by caries. The root of the tooth is sometimes, though rarely, affected, and presents an irregular knotted appearance.

The disease is often confined to a single tooth, but it more frequently shows itself on two corresponding teeth in the same jaw. According to our observation, the bicuspids are more liable to be attacked than any of the other teeth. The temporary teeth are rarely affected with it. This variety occurs less frequently than either of the others; and, although it increases the liability of the affected organs to caries, they sometimes escape until the twentieth or thirtieth year of age.

In the description which we have given of the three varieties of defective structure, we may have omitted to mention some of the peculiarities belonging to each, but we have pointed out their principal characteristics with sufficient accuracy to enable them to be distinguished one from another, and either from erosion.

The first variety is evidently produced by some cause capable either of preventing or destroying the bond of union between the enamel and subjacent dentine.

When the affection is congenital, as it almost always is, it is de-

pendent upon some disease in the pulp or intermediate membrane, which constitutes the bond of union between the dentine and enamel, subsequently to the formation of the latter, either simple local irritation, or general constitutional disturbance. One would be likely to suppose, if the defective spots were occasioned by disease of the pulp or intermediate membrane, the morbid action would scarcely confine itself to such narrow and circumscribed limits. But, whether the destruction of the intermediate membrane of the affected parts results as a consequence of actual disease, or merely from vicious nutrition, or whether from unknown causes it has failed to be developed here, it is certain that the fibres of this portion of the enamel are not united to the subjacent dentine; thus, not receiving a supply of nutrient fluid or vital principle, their animal framework partially or wholly perishes, leaving but little else than their inorganic constituents. The cause of this variety of congenital atrophy, it must be confessed, is very obscure; and, in the absence of positive knowledge, we can only infer the cause from the nature of the affection. If it does not result from one or other of the above-mentioned causes, it is difficult to imagine in what way it is produced.

The cause of the second variety may be due to some constitutional disease which may interrupt the secretion of the earthy salts deposited in the enamel cells or secretory ducts of the enamel membrane, for the formation of the enamel fibres; occurring at the time when this process is going on, it might prevent them from being filled, and cause them to wither or waste away, giving to this portion of the enamel the pitted appearance which characterizes this variety. In other words, the secretion of the inorganic constituents of the enamel being interrupted for a short time the horizontal row of cells in the enamel membrane, into which it should be deposited, will not be filled; consequently, as might readily be supposed, they will waste away, leaving a circular row of indentations around the crown of the tooth. But as soon as the constitutional disease has run its course, the secretion of the earthy salts will be resumed; and unless the child experiences a relapse, or has a second attack of disease, capable of interrupting this secretory process, the other parts of the enamel will be well formed.

Some writers ascribe the formation of these pits in the enamel to the chemical action of a corrosive fluid, or to an acidulated condition of the fluid contained in the dental sacs; but they have evidently confounded this affection with erosion. We believe, however, it almost always occurs as a consequence of some eruptive disease or catarrhal

fever occurring during the formative process; and there are many facts which go to sustain the correctness of this opinion. In nearly all the cases that have fallen under our observation, it was clearly traceable to measles, scarlatina, chicken-pox, catarrhal fever, or small-pox. It may, however, occasionally be produced by other constitutional diseases.

The third variety, so far as our observation upon this subject has permitted us to form an opinion, always results from altered or vicious nutrition, caused by disease of the pulp or enamel membrane, or both, during the secretion of the dentine or enamel, according as one or both are affected. We are inclined to believe that the disease in the dental pulp or enamel membrane may be produced either by local or constitutional causes, or both. But the information which we have been able to obtain in the cases that we have seen, concerning the state of the general health, and that of the mouth at the time of the dentification of the pulp and the secretion of the enamel, have not been as satisfactory as we could have wished.

Since writing the foregoing, the following interesting case of dental atrophy has fallen under our observation :—

Mrs. C. called to consult us concerning her daughter's teeth, which, from congenital defect, presented a most unsightly appearance. The girl was between nine and ten years of age. The cutting edges of the upper central incisors were badly pitted and very rough; the corresponding teeth in the lower jaw had a transverse row of pits passing around them, about a sixteenth of an inch below their cutting extremities. Another row of pits, so close together as to form a rough groove, encircled the upper central incisors, about an eighth of an inch below the gum, and the laterals a little nearer their cutting edges; the lower incisors were similarly marked, but not quite so near the gum. The enamel, near the second transverse row of pits, and between it and the cutting edges of the teeth, was thin and of a light-brown color. A little above the first row, on the central incisors, were two or three brown or opaque spots. The first permanent molars were also encircled with a row of indentations, about half-way between their grinding surfaces and the gums.

On inquiry, we learned from the mother that the child had a light attack of measles when between eleven and twelve months old, of scarlet fever when about fifteen or sixteen months of age, and dysentery at about the twenty-first or twenty-second month.

Now, here we have the three varieties of defective structure on

the same teeth; and the occurrence of constitutional diseases about the time when the affected parts of the teeth must have been receiving their earthy salts, which would seem to establish very conclusively the connection of the one with the other.

The nature of this affection is such as not to admit of cure. The treatment, therefore, must be preventive rather than curative. All that can be done is to mitigate the severity of such diseases as are supposed to produce it, by the administration of proper remedies. By this means their injurious effects upon the teeth may, perhaps, be partially or wholly counteracted.

In some forms of this affection the teeth may not decay more readily than others, so that the only evil resulting from the affection is a disfiguration of the organs; but in others, and especially in the pitted variety, it may be necessary to insert fillings at an early age. When the cutting edges of the incisors only are affected, the diseased part may sometimes be removed without injury to the teeth.

CHAPTER XI.

ORIGIN AND FORMATION OF THE TEETH.*

Of all the operations of the animal economy, none are more curious or interesting than that which is concerned in the production of the teeth. In obedience to certain developmental laws, established by an all-wise Creator, it is carried on from about the sixth week of intra-uterine existence, with the nicest and most wonderful regularity until completed, and excites in the mind of the physiologist the highest admiration.

From small papillæ, observable at a very early period of fœtal life, the teeth are gradually developed, and as they increase in size, the papillæ assume the shape of the crowns of the several classes of teeth they are respectively designed to produce. Having arrived at this stage of their formation, they now begin to dentinify, first upon the cutting edges of the incisors, the apices of the cuspids, bicuspids and eminences of the molars; from thence the process is continued over the whole surface of their crowns, until they

* The study of the "origin and formation of the teeth" should begin with the "development of the bones of the head and face" and the "description of the mucous membrane," to which subjects the reader is referred.

become invested with a complete layer of dentine; and so layer after layer is formed, one within the other, until the process of solidification is completed. Before the appearance of the dentinal germ or papilla, however, the enamel of the teeth begins to form, and when the enamel organ or cord has acquired the appearance of a hood ,or cap, and contemporaneous with this change, the dentinal papilla is developed, and this formative operation is gone through with previously to the completion of the dentinification of the pulp.

In the meantime, and in anticipation of the loss of the temporary teeth, a second set is forming, and as the teeth of the one series are removed, they are promptly replaced by those of the other. Thus, by a beautiful and most admirable provision of Nature, the first set of teeth, intended to subserve the wants only of childhood, while the jaws are too small for the reception of such as are required for an adult, are removed and replaced by a larger, stronger, and more numerous set.

The older writers, regarding a knowledge of the earlier stages of the development of the teeth as not of much importance, paid little attention to the subject, and hence this most curious and interesting department of developmental anatomy has remained, until recently, measurably uncultivated. Eustachius, we believe, was the first to notice the position and arrangement of the teeth in the jaws previous to their eruption. But his researches were confined to the examination of the jaw after birth, at which period he speaks of having discovered, by dissection, the incisors, cuspids, and three molars on each side, in each jaw, partly in a gelatinous and partly in a solidified condition. He also discovered the incisors and cuspids of the permanent set behind the first.

Eustachius wrote in 1563, and nineteen years later Urbian Hermard, a French anatomist and surgeon, although unacquainted with the work of the former, gave a very similar description of the situation of the crowns of the incisors and cuspids of both sets in the jaws of an infant at birth. He represents them as partly bony and partly mucilaginous. He also discovered the bicuspids; but he was unable to find the molars at so early a period as at birth.

The researches of Albinus threw no additional light upon the manner of the formation of the teeth, and little was known concerning the earlier stages of the development of these organs until the time of John Hunter, who informs us that in the alveoli of a fœtus of three or four months "four or five pulpy substances, not very distinct, are seen."

Although Mr. Hunter gives a more minute description of the pro-

gress of the formation and arrangement of the teeth in the jaws previously to their eruption than any previous writer, yet, with regard to their origin and appearance during the earlier stages of their development, he is unsatisfactory. Nor do the researches of Jourdain, Blake, Fox, Cuvier, Serres, Delabarre, Bell, and other writers, throw much additional light upon the subject. In fact, they could not, as their researches, except those of Mr. Bell, do not seem to have been commenced at periods sufficiently early in fœtal subjects; and even from the time when they were first instituted, the progress of the organs does not appear to have been traced through the subsequent stages of their formation with the requisite degree of care and accuracy. It is not, therefore, necessary to notice the descriptions given by these authors of the progress of the formation of the teeth.

The theories of Arnold and Goodsir, and especially the latter, were formerly universally accepted, but the later researches of Waldeyer and Dursy have shown them to be erroneous, and the theory of Waldeyer is now generally adopted.*

Commencing the description of the development of the teeth with the condition of the jaws of the embryo at the period of the formation of the organs which compose the "dental follicle," namely, the enamel organ, the dentinal germ or papilla, and the follicular wall or sac, there is at an early period no trace of osseous tissue in the *lower* jaw, the maxillary arch having within its component elements a symmetrical cartilaginous band, which extends its entire length, as far as the frame of the drum of the ear, and which is known as "Meckel's cartilage." This cartilage acts a transitory part only, until osseous tissue is developed, when it disappears, first by calcification, and afterward by ossification. (See Development of the Bones of the Head and Face. Figs. 2, 3, and 4.)

As regards the *upper* jaw, the same period of evolution as that of the lower jaw marks the union of the maxillary germs with the median or inter-maxillary germs, which occurs in the human embryo about the fortieth or forty-fifth day. On the surface or

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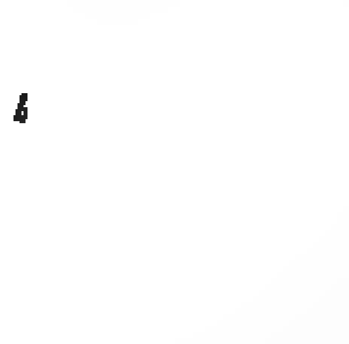
* According to the theory of Goodsir, at an early period of fœtal life there appears a continuous open groove running around the whole circumference of the jaws. From the bottom of this groove, which he styles the primitive dental groove, there arise isolated and uncovered papillæ corresponding in number to the deciduous teeth. These papillæ become covered in by the deepening of the groove, and the coming together of its two edges over their tops, while at the same time transverse septa are formed, so that the several papillæ become enclosed in separate follicles.

rounded portion of the two maxillary arches thus formed, and which later constitute the alveolar border or process, a depression or groove, called the "dental groove," appears, which, however, is so completely filled or "heaped up" with a bed of epithelial cells as to form a protuberance or smooth ridge, destitute of any fold or depression whatever.

FIG. 66.



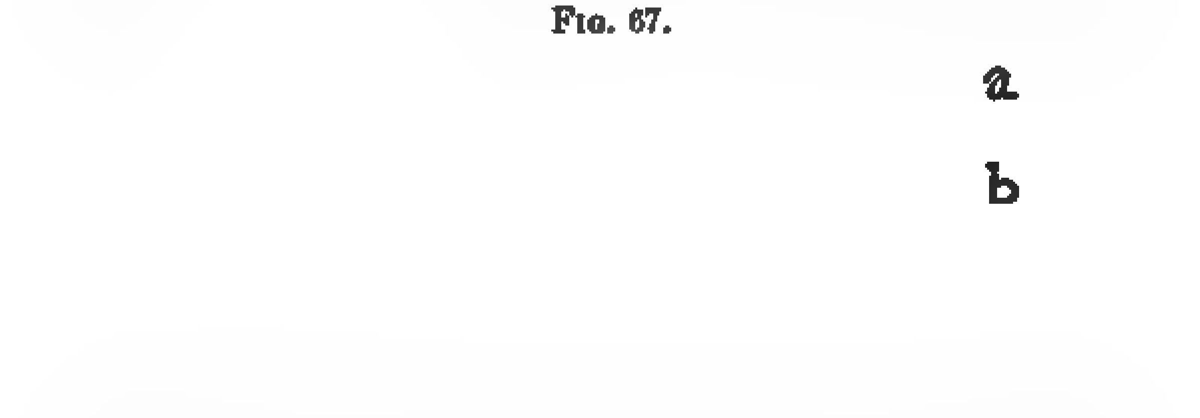
d, a mass of epithelium—the "dental ridge;" b, younger layer of epithelium; c, deepest layer of epithelium—the prismatic or columnar stratum; e, enamel germ.

This ridge (Fig. 66) is composed of a thick bed of epithelial cells, which, however, on its sides form a coat of a few rows of cells only, and does not include any other well-defined tissue unless it be some vessels, nerves, and muscle-fibres in process of development.

The principal structures of the teeth are derived from such elements as compose the epithelial structure and the tissues beneath which represent the corium and cellular tissue of the mucous membrane, beneath which is the ossifying substance of the jaw—the enamel being formed from the epithelium which fills the dental groove and constitutes the rounded projection or smooth ridge, and the dentine and cementum (crusta petrosa) from the deeper structures of the mucous membrane.

Development of the Enamel.—First, as to the development of the enamel, which is very similar to that of the hair follicle. About the sixth or seventh week of fœtal life, the epithelium fills the groove

FIG. 67.



a, flat layer of epithelium; b, proliferation of cuboidal layer, forcing columnar layer downward, producing V-shaped appearance. The removal of these upper layers leaves the "primitive dental groove;" c, lamina from which arise the epithelial cords of enamel organs.

or depression on the surface of the jaw so full that a small, rounded projection or ridge is formed, from the under surface of which a process sinks into the tissue beneath, the outlines of which resemble in shape the letter V with the apex slightly inclined toward the inner surface (Fig. 67). This epithelial process or band is simply a prolongation of the natural covering of the mouth, which sinks

into the embryonic tissue of the jaw, and forms for itself a groove which it completely fills, and is composed of the same histological elements as the epithelium of the mucous membrane of the mouth.

When this epithelial band is fully formed it presents two surfaces, an external and an internal, and from the latter a process is given off which forms the epithelial lamina. This epithelial lamina is a continuous process extending over the entire epithelial band, being an inflection of the band itself, and its elements are the same, namely, polygonal cells inclosed by a layer of prismatic cells.

The "dental follicle," which, as was before stated, consists of the enamel organ, the dentinal germ or papilla, and the follicular wall, is developed from points on the free extremity of the epithelial lamina. These follicles appear as small tubercles arranged at intervals on the free margin of the lamina, and correspond in number and location to the future deciduous teeth, being the primitive germs of the dental follicles, which retain their connection with the lamina by means of a slender cord, which gradually increases in length as the development of the germ at its extremity progresses. This germ constitutes the enamel organ, while the neck or cord in its progressive lengthening merely serves as a temporary connection with the lamina. This germ presents a spherical form in its early stage (Fig. 68), and is composed of an external layer of prismatic cells (ameloblasts) including a mass of polygonal cells. The younger layer, described as "infant cells," owing to the active cell-multiplication which takes place at the point where the epithelial cord for the tooth is to arise, sinks into the substance of the tissue beneath the epithelium in the form of a pouch. Some contend that the cells of this infant layer are not columnar, but are oval or spheroidal. The enamel organ at about the fourth month of the development of the embryo has undergone very considerable changes, the primitive polygonal cells which compose the central mass or middle region of this organ have been transformed into stellate bodies differing in appearance from the primitive cells, a process, however, which is confined to the cells of the enamel germ, and which does not take place in the cells of the epithelial cord or lamina, thus affording

FIG. 68.

PRISMATIC DENTAL FOLLICLE.

c, prismatic or columnar cells; *d*, large polygonal cell of the epithelial band; *F*, small cells of the epithelial laminæ.

evidence that the constitution of the one differs from that of the other.

These stellate cells (Fig. 69) are composed of a central nucleus surrounded by a transparent or finely granular mass, which mingles with the neighboring elements.

They occupy at first only the centre of the enamel organ, and those near the 'periphery preserve their primitive polygonal form, but

FIG. 69.

STELLATE CELLS OF THE ENAMEL ORGAN.
(Diagrammatic, from *Frey*.)

FIG. 70.

Represents the hexagonal form assumed by the base of the stellate cells.

become stellate as the organ increases in size, and are formed from the original elements composing the internal mass of the enamel organ, being epithelial in their nature.

After a time the base of these stellate cells presents the regular prismatic form of a hexagon (Fig. 70).

During this modification of the enamel germ, no change appears to take place in the epithelial lamina.

The primitive enamel germ at length loses its original spherical form, and becomes somewhat cylindrical, pursuing a horizontal course until it undergoes a considerable increase in length, when, by an abrupt turn, it takes a vertical direction and sinks into the tissues of the jaw.

During such a progress the cord acquires a length in accordance with the requirements of the jaw.

After the epithelial cord has changed its course from a horizontal to a vertical direction, its extremity expands and assumes a club-shape, on account of the multiplication of the polyhedral cells of which its greater portion is composed, and also of the prismatic cells that surround it. This expanded extremity also becomes somewhat spherical, and its upper portion corresponds to the point of connection with the cord, while the lower portion points toward the base of the lower jaw.

This condition represents a fully formed enamel organ, which is

the first trace of the dental follicle. Very soon the lower portion of the enamel organ becomes concave, and assumes the form of a cap or hood, although still retaining its connection with the epithelial cord. At this stage in the development of the enamel organ the dentinal germ or papilla makes its appearance.

During the development of the primitive epithelial cord, lateral germs similar to small rounded nodules, in the form of varicosities,

FIG. 71.

JLW Del.

a, epithelial layers of mucous membrane lining mouth; *b*, embryonal corpuscles of dermal tissue of jaw; *c*, budding of cord of permanent tooth from cord of temporary tooth; *d*, enamel organ of temporary tooth; *e*, columnar or prismatic layer of cells from which ameloblasts or enamel cells are formed; *f*, dentine germ formed from embryonal corpuscles of dermal tissue; *g*, commencing ossification of inferior maxilla; *h*, V-shaped band, resulting from proliferation of cells of cuboidal layer; *i*, development of connective-tissue cells from embryonal corpuscles, forming sac which incloses tooth-germ.

make their appearance, and which, according to Magitot, resemble an irregular chaplet or chain. These lateral germs are composed of small polyhedral cells, like those of the cord itself, with walls formed of a layer of prismatic cells in continuation of the Malpighian layer of the epithelium. From these lateral germs or masses, at a later period, after the cord is ruptured, epithelial prolongations arise.

The primitive cells during the early stage of evolution present the same characteristics on all parts of the periphery, but as soon as the dentinal germ or papilla begins to appear these primitive cells on the concave surface lengthen, while those of the convex surface decrease in size until they disappear entirely, before the atrophy of the enamel pulp; and those of the internal surface remain for the formation of the enamel organ.

Besides increasing in length, the prismatic cells of the concave surface of the enamel organ undergo changes, their extremities, directed toward the centre of the enamel organ, forming slender

FIG. 72.

ENAMEL ORGAN AND "NASMYTH'S LAYER" OF CELLS, DRAWN UNDER A MAGNIFYING POWER OF 1800 DIAMETERS.

a, portions of the reticulum which lie exactly in focus; the points of intersection are seen to be made up of a finer and more delicate reticulum; *b*, parts which lie a little beyond focus; *c*, granular matter held in the meshes of the reticulum; *d*, "Nasmyth's membrane," or layer of flat cells, just outside of enamel cells.

processes, which either unite, or are continuous with filaments from surrounding cells, which constitute the portion of the enamel organ designated as the *stratum intermedium*. The stratum intermedium consists of cells which, according to Mr. Tomes, are intermediate in character between those of the bordering epithelium and the stellate reticulum, being branched, but less conspicuously so than the stellate cells with which they are continuous on the one hand, and on the other with the enamel cells. According to Waldeyer, Hertz and Hannover, since the enamel cells may be frequently seen connected at their lower extremities with the cells of the stratum intermedium, a multiplication of enamel cells from the cells of this stratum, in the direction of their length, may be admitted to occur.

According to Dr. G. V. Black, and quoted by Dr. M. A. Dean, "just before the calcification, and even before the odontoblasts make their appearance, the ameloblasts (prismatic cells), and the tissues of the pulp are separated by a well-marked double pellucid layer, which in sections appears as a double band." This double band is represented in Fig. 73 by the two white parallel lines, *A A*, the upper one being the tissue which is identical with the *membrana præformativa* of Huxley, while the lower one represents the *basement membrane* of Ladd and Bowman, and the *membrana præformativa* of Raschkow.

FIG. 73.

A. A.

B, M, basement membrane; *N*, neck; *S*, sac or follicular wall; *O*, enamel organ; *B*, bulb; *E, E*, external epithelium of the enamel organ and the basement membrane; *E, C*, epithelial cord; *C, T*, connective tissue surrounding the enamel organ; *Ep*, epidermis or oral epithelium.

The parts embraced between the points where the divergent lines *A, A* terminate are: (1) The concave face of the enamel organ, lined with a layer of ameloblasts, or the "internal epithelium." (2) The membrana præformativa of Huxley, or the tissue composed of the basal coverings of the ameloblasts. (3) The membrana præformativa of Raschkow, or the basement membrane. (4) The dentine bulb itself. Diagrammatic.

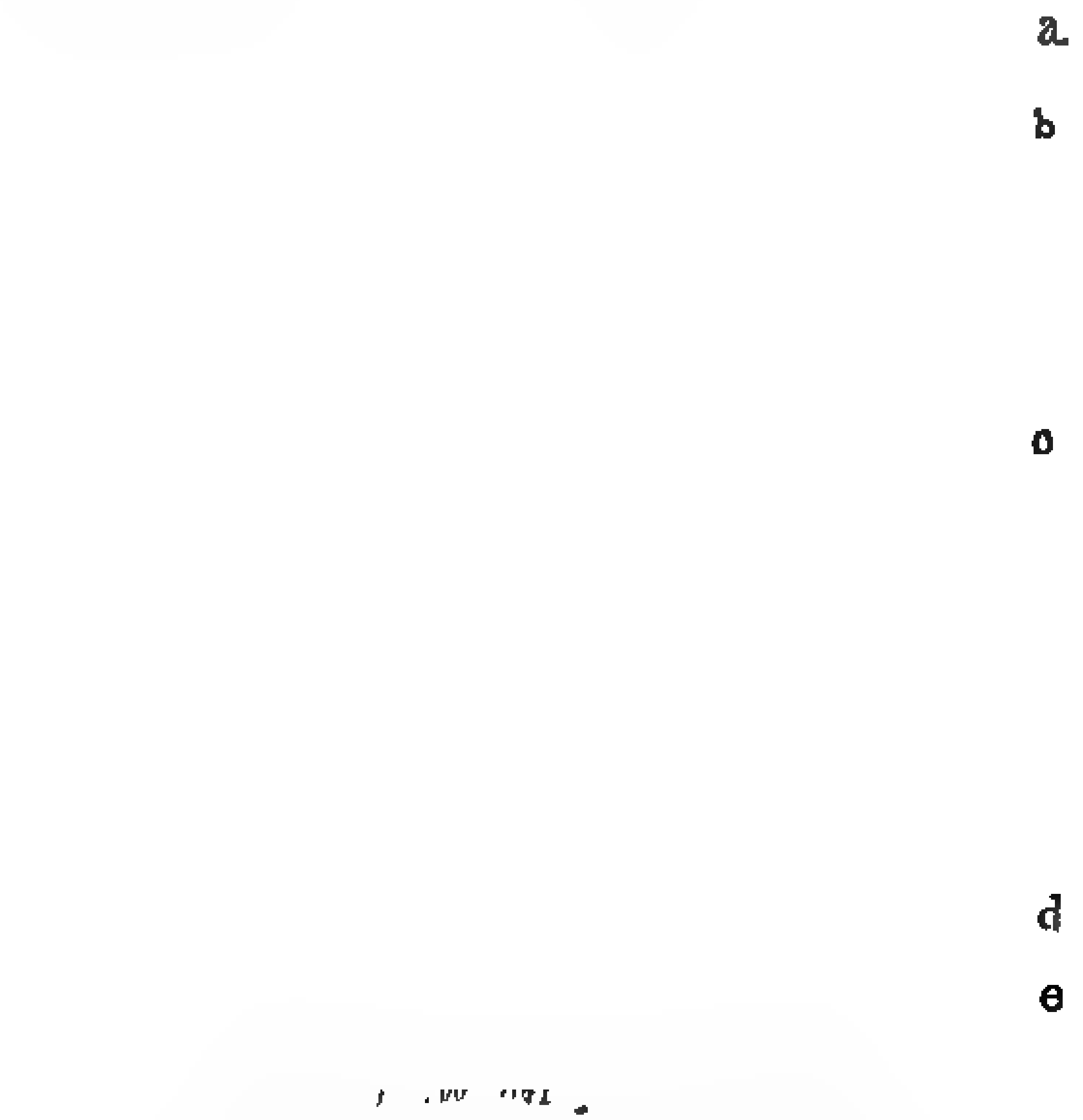
After the epithelial cells are changed into hexagonal prisms, these anastomose and form the hexagonal rods characteristic of fully matured enamel.

The epithelial covering on the outer surface of the enamel remains distinctly perceptible, and after the eruption of the crown of the tooth this layer, which is known as the "dental cuticle"—*cuticula dentis*, and also as "Nasmyth's membrane," may be separated from the enamel surface beneath it by strong acids, when the hexagonal depressions of enamel prisms are apparent, and on the application of nitrate of silver the characteristics of epithelium appear.

Dr. J. L. Williams, in an able article on "embryology," dissents from the opinion of Legros and Magitot concerning the function of the *membrana præformativa* of Raschkow, and positively denies that it has any modifying influence in the process of the development of the teeth; and, while he is not prepared to deny *in toto* the existence of this membrane, says that an examination of many specimens failed to discover this structureless, transparent tissue; and he asks, "How is it possible that the odontoblasts, which are more than $\frac{1}{3000}$ of an inch in diameter, can be developed in a membrane which Beale says is "certainly less than the $\frac{1}{20000}$ of an inch in thickness." Dr. Williams also remarks: "It has been supposed that the so-called ameloblasts, or enamel cells, are formed directly

from the layer of columnar or prismatic epithelium which covers the face of the enamel organ." But preceding the development of the enamel cells, the original prismatic cells break up or divide into round, nucleated corpuscles, which change is denominated by Professor Heitzmann and Dr. Atkinson a return to an embryonal condition."

Fig. 74.



THE SPECIMEN FROM WHICH THIS DRAWING WAS MADE WAS PLACED UNDER A ONE-TENTH INCH IMMERSION LENS, MAGNIFYING ABOUT 800 DIAMETERS.

a, connective tissue of tooth-sac; *b*, capillary vessels cut transversely and longitudinally, and filled with blood-corpuscles; *c*, reticulum of enamel organ; *d*, round and flat layer of cells, forming the so-called "Nasmyth's membrane;" *e*, ameloblasts or enamel cells.

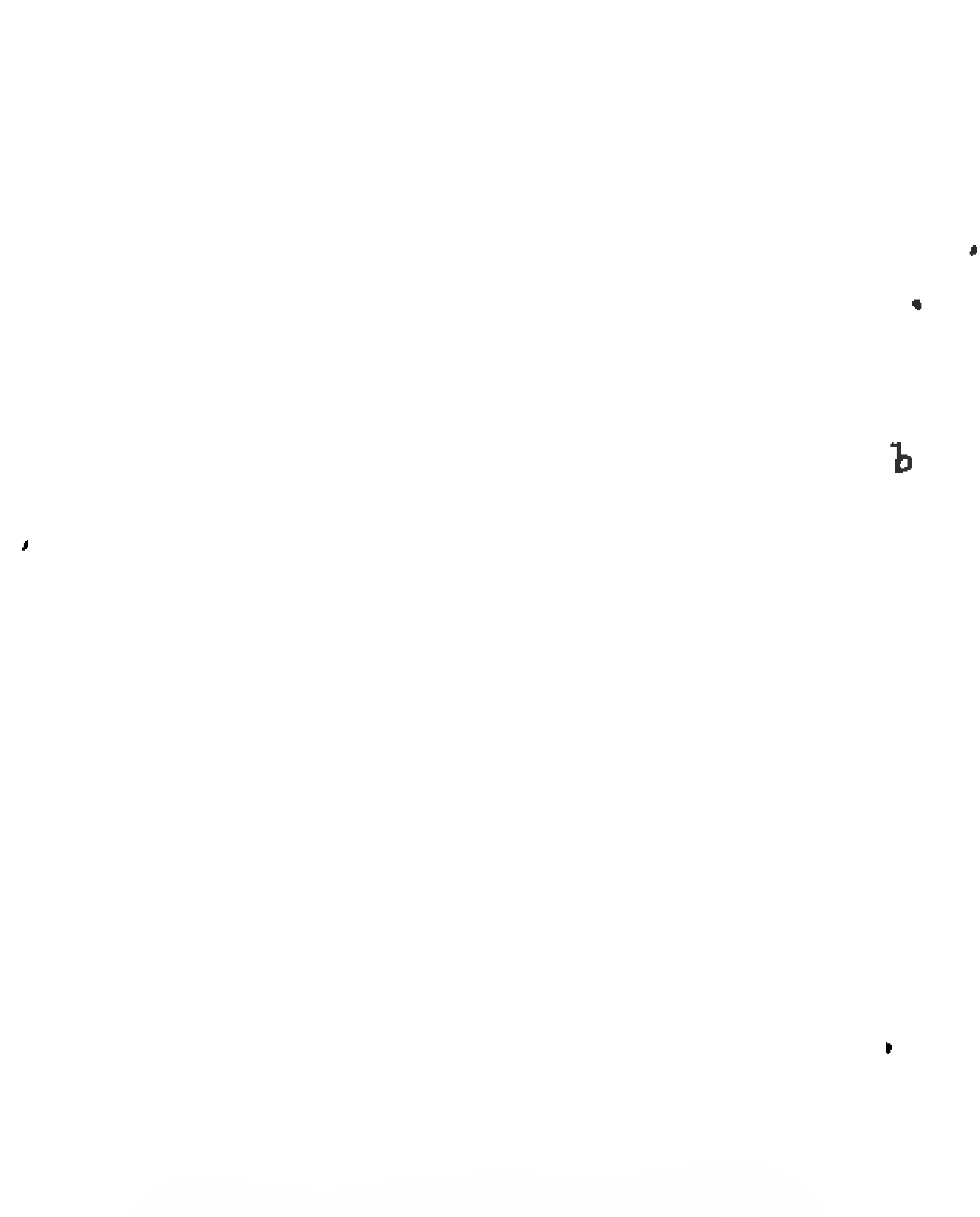
"From these embryonal corpuscles are developed the enamel-forming cells, and also an outer layer of smaller cells, from which is formed Nasmyth's membrane."

The same author also regards the enamel organ as a "true secreting organ," and that the material for the formation of enamel has no other evident source.

Development of the Dentine.—As the epithelium is undergoing this peculiar development into the enamel organ, a projection of the corium of the mucous membrane of the fœtal jaw rises up to meet

it out of the dental groove. This projection is the dentinal papilla or germ, which is described, after Dursy and Waldeyer, as a ridge, "the intervening parts of which are atrophied so as to leave papillæ or

FIG. 75.



DRAWN UNDER THE SAME MAGNIFYING POWER AS FIG. 74.

a, connective-tissue cells of tooth-sac; *b*, reticulum of enamel organ. In this drawing it is seen that the reticulum holds in its meshes very large, soft, granular corpuscles, heretofore known as the gelatinous fluid of the enamel organ; *c*, breaking down of columnar layer of cells into embryonal corpuscles, from which ameloblasts are developed.

germs which become coated all over by the enamel organ, and thus the saccular stage of the teeth is produced, the papillæ which are to

form the bulk of the teeth being coated with a vascular connective tissue, isolated by the enamel organ and separated from each other by the growing (osseous) tissue of the fœtal jaw."

Dursy, according to Waldeyer, says: "The first germ of the dentine appears in the dental *sacculus*, as a dark semi-lunar area at the bottom of the dental groove—that is to say, of the enamel germ—cöetaneously and continuously with which it is developed along each half of the jaw. At certain points corresponding to the position of the subsequent teeth, the young structure develops in the form of papillæ, projecting against the enamel germs, while the remainder

FIG. 76.

a, Meckel's cartilage; *b*, traces of ossification; *c*, lowest layer of Malpighian stratum; *d*, oral epithelium; *F*, ameloblastic or prismatic layer; lower *F*, external layer of enamel organ; *g*, stellate reticulum of the enamel organ; *H*, dental germ or papilla; *I*, follicular walls.

atrophies. The two horns of the semi-lunar mass (as seen in section) extend from the base of the dental papilla some distance upward, and embrace the dentine germ and enamel organ."

According to Dr. Sudduth, the epithelial cord does not penetrate the underlying tissue searching for a dentinal papilla, but it has the power to superintend the differentiation of a papilla for itself.

As the dentinal papilla or germ increases in height, it assumes a slightly oblique direction in relation to the axis of the follicle, and at the same time becomes constricted at its base, thus forming a neck at the line where the enamel organ is reflected back upon itself (Fig. 76).

The follicular wall, which forms a part of the dental follicle, first appears as a process arising from the base of the papilla, to the neck of which it is attached like a slight collar. Its development begins as soon as the small mass which constitutes the dentinal germ assumes a hemispheric form. The follicular wall, by its gradual upward growth, at length embraces and isolates both the enamel organ and the dentinal papilla, and during its evolution, from being composed of embryoplastic elements, by degrees assumes the appearance of a distinct laminated membrane, which may be separated from the adjacent tissue, except at the base of the papilla to which it remains adherent. According to both Kölliker and Huxley, the transparent stratum (*membrana præformativa*) which invests the dentinal papilla reflects itself back on its internal surface, and thus lines the whole inner surface of the follicular wall.

FIG. 77.

a, wall of the sac, formed of connective tissue, with its outer stratum a^1 and its inner a^2; *b*, enamel organ, with its papillary and parietal layer of cells; *c*, *d*, the enamel membrane and enamel prisms; *e*, dentine cells; *f*, dental germ and capillaries; *g*, *i*, transition of the wall of the follicle into the tissue of the dental germ.

As the evolution of the follicular wall progresses, it closes over the contents of the dental follicle, which, besides the wall, consist of the enamel organ and the dentinal papilla; the enamel organ being subjacent to the follicular wall, to which it conforms in such a manner that, while the external face of the organ is in relation with the wall, the lower concave face is in immediate contact with the papilla. The dentinal papilla occupies the lower and central portion of the follicular sac.

The enamel organ fills the entire space between the sac wall and the papilla, terminating at the base of the latter in a rounded margin which forms the dividing line between the prismatic cells which cover its concave and convex surfaces (Fig. 77). The dental follicle is of an ovoid form, and varies in size according to the class of tooth to be developed from it; and when it is completely formed, it remains inclosed within the embryonal tissues of the jaws, with which it is at first only slightly connected.

When the rupture of the epithelial cord occurs, it loses its communication with the mucous membrane, and forms no connection with the maxillary bone, as the alveolar processes are not developed until a later period.

The rupture of the epithelial cord, which brings about the isolation of the dental follicle from the mucous membrane, is due to the upward growth of the follicular wall, which closes over the top of the enamel organ, beneath which is the papilla, the union of the edges of the wall producing compression or strangulation of the cord at that point. At this period of evolution, the saccular stage, the dental follicle is completed, and from the cells of the dentinal papilla a soft matrix of animal matter is formed, which becomes impregnated with calcareous matter to form the complete dentinal tissue, while in the interior of the cavity of the dentine cells are formed, which continue to form new matrix for a considerable time.

After the dentinal papilla has become coated over by the enamel organ, and the saccular stage of the teeth is produced, and the papillæ have become separated from each other by the developing tissue of the embryonic jaw, odontoblasts (dentine cells) begin to form. These odontoblasts are large nucleated cells of elongated form, containing numerous processes developed from the cells of the dentinal papilla, which at that early period consist of fine fibrous tissue with numerous cells.

The odontoblasts send out processes which, as they develop, calcify externally, the calcified portion forming the dentine, and the uncalcified part the dentinal fibrillæ, and the lateral branches of anastomosis whereby the tubuli or canals of the dentine anastomose. The remains of the odontoblasts form a cellular layer which constitutes the investment of the pulp lying between its nerves and vessels and the dentine. This cellular layer is known as the "ivory membrane"—*membrana eboris* of Kölliker.

The enamel organ is non-vascular, but a network of vessels is furnished to the follicular wall and the dentinal papilla from the surrounding tissues.

At the period when the epithelial cord is ruptured, the cells composing the epithelial lamina become greatly increased in number, and irregular proliferations or "buddings" occur, which wander by different courses into the deeper portions of the embryonal tissue. These buddings differ in form, sometimes in that of cylinders which retain their connection with the primitive lamina; but frequently this connection is absorbed, and an epithelial mass is set free. Clusters of these masses occasionally take the globular form, resembling those in the lamina itself, but frequently they become absorbed

and disappear before the development of the tooth is completed. At the time the absorption of the epithelial lamina is taking place, changes precisely analogous are transpiring in the severed epithelial cord.

From the remains of this cord processes are given off, which at times become quite numerous, and may remain almost to the time of the eruptive stage of the tooth.

The direction of these processes is toward the epithelium, and they consist of the same polyhedral cells as the cord and lamina, but are never invested with prismatic cells. All these epithelial

FIG. 78.

a, Meckel's cartilage; *b*, traces of ossification; *c*, lowest layer of Malpighian stratum; *d*, oral epithelium; *F*, ameloblastic layer; *lower F*, external layer of enamel organ; *H*, dentinal papilla; *I*, follicular wall; *K*, buddings of epithelial cord.

proliferations finally disappear by absorption, unless some such masses may become detached and wander into the deeper tissues; for it is considered by some eminent histologists that a dentinal papilla or germ may originate from any point of the dentinal sheet of tissue with which the epithelial mass comes in contact, and that it is solely through the influence of the enamel organ upon this tissue that the development of the dentinal papilla is induced.

Immediately after the rupture of the epithelial cord, the formation of the secondary follicle of the permanent tooth begins. There is no trace of the osseous tissue of the jaw at the time of the origin of the primitive epithelial cord. Bone first makes its appearance

near the base of the follicles, forming a horizontal layer, and separating the groove of the follicles from the canal reserved for the vessels and nerves. From the layer or floor, lateral processes arise and form the dental groove, in which the follicles remain for some time without being separated by transverse partitions, and it is only after the development of the crowns of the teeth has commenced

FIG. 79.

FROM THE UPPER JAW OF A KITTEN, ABOUT THE TIME OF BIRTH.

a, oral epithelium; *b*, bone of jaw; *c*, neck of enamel organ; *d*, dentinal papilla; *e*, enamel cells, *f*, stellate reticulum; *h*, germ or papilla of permanent tooth, the enamel organ of which is derived from the primary cord.

that bony processes are thrown across the groove, forming receptacles for the lodgment of each follicle with an opening in the direction of the epithelial surface (Fig. 79).

Development of Cementum (*Crusta Petrosa*).—There appears to be a difference of opinion among histologists concerning the origin of the cementum. Magitot, in 1858, and again Robin and Magitot, in 1861, described a new tissue, which, some time before the formation of the first dentine cap, was supposed to exist between the follicular wall and the organs within it—the enamel organ and the papilla—differing from the other tissues in color, consistence and structure, and upon which the formation of the cementum depended.

On the other hand, Kölliker, Waldeyer, Hertz, Kollman, and others, deny the existence of such a membrane or tissue, and ascribe the formation of the cementum (which resembles ordinary bone, as it contains canaliculi and lacunæ), to a periosteal origin—that it is developed from the deeper tissues of the fœtal jaw by periosteal ossification, the process being similar to that of bone formation in other parts of the body.

Origin of the Permanent Teeth.—While Goodsir held that the follicles of the permanent teeth originate from a fold of the sac of the primitive or deciduous follicle, the later investigations of Kölliker and Waldeyer have shown that the permanent follicles of teeth that have deciduous predecessors arise from certain prolongations of the primitive epithelial cord

The germ of the permanent follicle originates at a point where the primitive epithelial cord merges into the enamel organ of the temporary tooth, and is an outgrowth of this cord (see Fig. 80). The permanent cord takes a vertical direction, and passes between the bony alveolar wall and the primitive follicle, and then along the inner or lingual face of the follicle, its elements being the same as those of the primitive cord.

The permanent dentinal papilla or germ sinks to the bottom of the osseous dental groove, where it soon loses its connection with the primitive follicle, though still retaining its relation with the epithelial lamina.

The primitive follicle, however, by the severance of its cord at a point just below where the germ of the permanent or secondary cord arises, loses all connection with the epithelial lamina, and develops as an independent body or organ.

FIG. 80.

SECTION OF THE LOWER JAW OF A HUMAN FŒTUS.

9½ inches in length, corresponding to about the eighteenth week. (Magnified 80 diam.)

K, cord or bourgeon of the secondary follicle; *L*, point where its separation from the primitive cord is being effected; *a*, Meckel's cartilage diminished by absorption; *b*, bone of the jaw; *c*, (upper) dental artery, (lower) dental nerve; *d*, epithelium; *E*, originally the cord of the temporary follicle, but now the sole property of the permanent one.

The sinking of the follicle of the permanent tooth is soon followed by the entire series of phenomena which characterize the growth of every dental follicle; and while the permanent follicle is being developed, the remains of the ruptured primitive cord which continues to be attached to the primitive follicle are subject to that "budding" process which invariably commences at the moment this cord is severed—about the fourth month, or quickening period. The direction of the permanent cord being vertical, its length is governed by the height of the alveolar

border and the direction of the primitive follicle. When sinking into the substance of the jaw, the permanent cord always assumes a spiral form, and to such a degree that it can be readily distinguished from the primitive cord, as this latter is never so distinctly spiral in form as the former.

This spirality of form peculiar to the permanent cord is occasioned by the greater distance this cord must traverse in the more

FIG. 81.

VERTICAL SECTION OF THE LOWER JAW OF A HUMAN FOETUS,

Measuring 18¾ inches; corresponding to nearly the thirty-ninth week of gestation. The figure represents a cut passing through the follicle of a bicuspid.

b, bone of the jaw; *d*, oral epithelium; *g*, enamel organ; *H*, dental bulb; *K*, *débris* of the cord of a permanent follicle; K', K', epidermal globules. Follicle for the permanent tooth connected with the *débris* of its cord, *K*.

developed tissues of the jaw, to permit the permanent follicle to accomplish its passage to a point under the temporary tooth, and thus prevent the stretching of the cord and the disturbance of the parts with which the cord and enamel organ are connected. The spiral nature of the cord continues from its origin towards its termination in a rounded or club-shaped enlargement, similar to that of the extremity of the primitive cord, this enlargement representing the enamel organ of the permanent tooth.

At the period in the evolution of the permanent follicle when the

dentinal papillæ becomes unicuspid for the incisors and canines, and multicuspid for the molars, the permanent epithelial cord, which has already been for some time severed from the primitive cord and follicle, also loses its connection with the permanent follicle, and has no communication afterwards with the epithelial lamina. This severance is soon followed by the separation of the permanent cord into fragments, which, as was before stated, bud and lengthen in different directions, and become mingled and confounded with those of the primitive cord, anastomosing with them to form a sort of plexus. Finally, all these epithelial masses atrophy and disappear.

The above description applies to the development of the permanent teeth that have temporary predecessors. But the origin of the permanent teeth that appear back of the temporary teeth, and have no deciduous predecessors, is entirely different.

The first permanent molar, the follicle of which makes its appearance during the fifteenth week of embryonal life, and only a few days after the greater number of those of the deciduous teeth, and yet does not erupt until about the sixth year, originates directly from the epithelium of the mucous membrane, the epithelial cord from which penetrates the fœtal tissue in a region where no follicle has preceded it.

The second permanent molar originates from an outgrowth of the epithelial cord of the follicle of the first permanent molar, resembling in this respect the twenty anterior permanent teeth, but differing in the direction of its course. While the teeth derived from the temporary follicles pass over the lingual face of the latter to a position beneath them, that of the second permanent molar takes a horizontal direction for some distance, and then by an inflection takes its position at the posterior side of the follicle of the first molar, where it is developed in a line with those anterior to it (Fig. 54).

The origin of the third molar or wisdom tooth is effected in the same manner as that of the second permanent molar, as the epithelial cord that forms its enamel organ emanates from the cord of the second permanent molar. Hence we find the cord of the first permanent molar originating from the epithelium; that of the second permanent molar from the cord of the first permanent molar; and that of the third molar from the cord of the second permanent molar.

Dr. G. V. Black, whose extensive researches in dental histology are worthy of all praise, is of the opinion that, "although the epithelial cords of the twenty anterior permanent teeth generally arise from those of the temporary follicles, yet they do sometimes emanate directly from the epithelium of the mucous membrane."

If such is the case, the secondary or permanent epithelial cords

may originate from either the primary cord, the temporary follicle, or the epithelial lamina. The follicles of the temporary teeth are developed during the period between the latter part of the third month of gestation and the beginning of the fourth year—within forty-two months—while the follicles of the permanent teeth require a much longer time for their evolution. It would seem quite reasonable to suppose that the dentinal papilla acts as an organic mould upon which the elements of the enamel are coated, but Magitot asserts that as the epithelial cord which represents the future enamel organ always precedes the appearance of the papilla,

FIG. 82.

SECTION ON A LINE WITH THE FOLLICLE OF THE FIRST PERMANENT MOLAR.

Human subject, three months after birth. Magnified 80 diameters.

b, maxillary bone; *c*, *c*, dental artery and nerve; *E*, cord of the follicle of the first permanent molar; *g*, enamel organ; *H*, bulb of the first permanent molar; *K*, bourgeon of the enamel organ of the second permanent molar.

which is never formed until the cord has advanced a certain distance, this cord decides not only the *place of genesis*, but the *form* and function of the corresponding tooth. According to Dursy, a dentine germ or papilla may be developed from any point of the semi-lunar area which is found below the enamel organ as soon as such a point is reached by this organ, and the dentine germ depends upon the course which the enamel organ takes. For example, if the epithelial cord of a canine should take an unnatural course, so as to come in contact with the dentinal tissue at a point between the bicuspids, the canine would be developed between those teeth;

hence it seems reasonable to conclude that the enamel organ determines the form and character of the future tooth.

Although the proliferations or buddings of the remains of the epithelial cord, after its severance from the enamel organ, usually disappear by absorption, yet it is possible that some such masses, meeting with dentinal tissue, may become the enamel organs of supernumerary teeth.

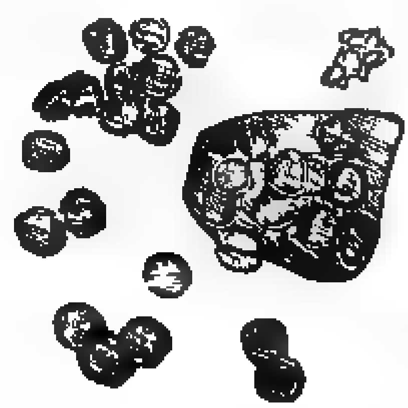
THE DENTAL PULP.

The pulp, occupying the pulp-cavity in the centre of the tooth, is the shrunken condition to which the tooth-germ, or dentinal papilla, is permanently reduced after it has normally accomplished the work of dentinification, and affords the vascular and nervous supply of the dentine. In the development of the dentine-dentinification, the thicken-

Fig. 83.

A PORTION OF THE BODY OF THE PULP, SHOWING THE CELLULAR ARRANGEMENT.

Fig. 84.



A PORTION OF THE SUPERFICIAL LAYER OF THE PULP, SHOWING THE APPEARANCE OF VESICLES.

ing of the dentinal wall is produced by the primary single layer of odontoblasts, and this thickening is not only at the expense of the pulp-cavity, but of the pulp itself, which gradually diminishes in size as the dentine increases in bulk. The dental pulp is an exquisitely sensitive, highly vascular substance, of a reddish-gray color, enveloped in an exceedingly delicate and apparently structureless membrane, continuous with the alveolo-dental periosteum, and adherent to the walls of the pulp-cavity. This is designated by Mr. Thomas Bell "the proper membrane of the pulp," and by Purkinjé and Raschkow, "the preformative membrane;" because, in the formation of the dentine, the deposition of earthy salts, according to these authors, commences in it.

The pulp, according to the two last-mentioned authors, is composed of minute globules. Schwann describes it as consisting of globular, nucleated cells, with vessels and nerves passing between them, the cells having the same radical course as the fibres of the dentine. According to the microscopic observations of Mr. Nas-

myth, it is principally composed of minute vesicular cells, varying in size from the ten-thousandth to the one-eighth of an inch in diameter, disposed in concentric layers; these, when macerated, have an irregular, reticulated appearance, and are found to be inter-

Fig. 85.

a, The vessels of the pulp of an upper central incisor injected, as seen under the microscope, very highly magnified; *b*, the natural size of the pulp.

spersed with granules, the parenchyma being traversed by vessels having a vertical direction. See Figs. 83 and 84, copied from Mr. Nasmyth.

Mr. Tomes describes it as consisting, from its earliest appearance,

of a series of nucleated cells, united and supported by plasma; also, prior to the commencement of the formation of the dentine, of delicate areolar tissue, occupied by a thick, clear, homogeneous fluid or plasma. The pulp is liberally supplied with blood-vessels, furnished by the trunk which enters its base. The ramifications of these vessels are distributed throughout its entire substance, forming a capillary network which terminates in loops upon its surface.

Three or more arteries enter at the apical foramen, and supply the pulp, dividing into branches, which, after pursuing a parallel course, form a capillary plexus immediately beneath the cells of the *membrana eboris*, or ivory membrane. The nerves of the pulp enter the apical foramen by one large and three small trunks, and, like the arteries, pursue at first a parallel course, and then form in the bulb a rich plexus beneath the membrana eboris. The nature of the terminations of the nerve fibres in the pulp is yet uncertain. Magitot states that he has fully satisfied himself that the nerves become continuous with the blanched, somewhat stellate cells, which form a layer beneath the odontoblasts, and, through the medium of these cells, with the odontoblasts themselves. Concerning this, Mr. Charles Tomes remarks: "If this view of their relation to the nerves be correct, the sensitiveness of the dentine would be fully accounted for without the necessity for the supposition that actual nerve fibres enter it, for the dentinal fibrils would be, in a measure, themselves prolongation of the nerves."

Fig. 86.

THE NERVES OF THE PULP OF AN UPPER ADULT BICUSPID, MAGNIFIED TWENTY DIAMETERS.

The distribution of the vessels of the pulp is represented in Fig. 85, copied from the work of Mr. Nasmyth, and made from an injection preparation of an upper central incisor. The communication of the arteries with the veins by means of a series of looped capillaries, presenting a densely matted appearance upon the surface, is beautifully represented. The nerves of the pulp have a very similar arrangement in their distribution, having apparently looped terminations (Fig. 86). Kölliker describes the pulp as consisting of an indistinctly fibrous connective

tissue, containing many dispersed, rounded and elongated nuclei, with, occasionally, narrow bundles somewhat like imperfect fœtal connective tissue filled with a fluid substance. Immediately beneath the structureless membrane in which these tissues are enclosed, there is a layer composed of many series of cells, cylindrical or pointed at one end, with long and narrow nuclei, arranged perpendicularly to the surface of the pulp, like a cylinder of epithelium. This layer is described as being from two to four one-hundredths of a line in thickness. These, in regular series proceeding internally, become less and less distinct; "but the cells, without losing their radial arrangement, are more intermixed, and pass finally, by shorter and rounder cells, without any sharp line of demarcation, into the vascular tissue of the pulp." His description of the distribution of the vessels and nerves of the pulp is similar to that given by Mr. Nasmyth and Mr. Tomes.

The dental pulp undergoes considerable change in advanced age, diminishing in size by its progressive calcification.

Further degeneration shows an atrophied condition of the odontoblastic layer, and coincidently with the diminution in the quantity of the cellular elements, an increase of the fibrillar connective tissue. At last the capillary system becomes obliterated, according to Mr. Charles Tomes, "by the occurrence of thrombosis (effusion of blood into the cellular substance) in the larger vessels, the nerves undergo fatty degeneration, and the pulp becomes a shrivelled, unvascular, insensitive mass."

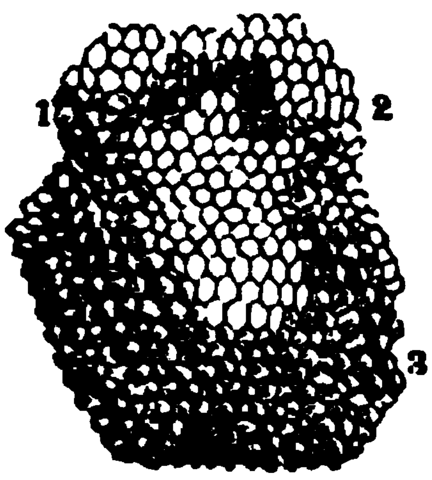
CHAPTER XII.

TOOTH STRUCTURES.

Enamel.—With regard to the formation of the enamel, the dental follicles have their origin in a cord which emanates from the epithelial layer of the mucous membrane of the mouth. These cords arise directly from a process of the oral epithelium, those of the permanent teeth, which succeed the deciduous ones, being outgrowths from the primitive cords. Concerning the cords of the other permanent teeth, those for the first molars originate directly from the epithelium of the mucous membrane, and the remaining ones from the cords of the preceding molars. The enlarged extremity of the cord constitutes the *enamel organ* of the future dental follicle. (See Origin and Formation of the Teeth.)

When the enamel is first deposited upon the surface of the dentinal papilla, it is of a chalky appearance, and afterward attains the glossy hardness by which it is characterized, with a white appearance, like porcelain.

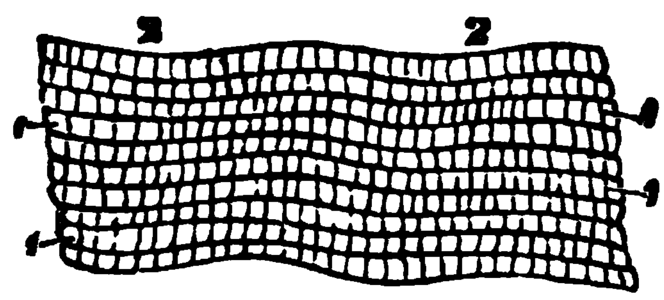
FIG. 87.



THE HEXAGONAL TERMINATION OF THE FIBRES OF A PORTION OF THE SURFACE OF THE ENAMEL; HIGHLY MAGNIFIED.

At 1, 2, 3, the crooked crevices between the hexagonal fibres are more strongly marked.

FIG. 88.



A SIDE VIEW OF THE ENAMEL FIBRES; MAGNIFIED 800 TIMES.

1, The enamel fibres; 2,2, transverse striæ upon them.

The enamel forms a smooth, dense layer enveloping the crown of the tooth as far as the neck, where it insinuates itself between the cementum and dentine. It is thickest on the cutting edges and grinding surfaces of the teeth, tapering to a thin edge at their necks. In color it is rather translucent than white. The analysis of enamel consists of

Calcium Phosphate,	85.8
Calcium Carbonate,	8.0
Calcium Fluoride,	3.2
Magnesium Phosphate,	1.5
Sodium Salts,	1.0
Animal Matter and Water,	1.0

Von Bibra gives the following:—

	Adult Man.	Adult Woman.
Calcium Phosphate and Fluoride,	89.82	81.63
Calcium Carbonate,	4.37	8.88
Magnesium Phosphate,	1.34	2.55
Other salts,	.88	.97
Cartilage,	3.39	5.97
Fat,	.20	a trace
Organic,	3.59	5.97
Inorganic,	96.41	94 03

Enamel consists of hexagonal or polygonal fibres or rods arranged in waved lines perpendicularly to the dentine. Those fibres or rods,

Fig. 89.

HUMAN ENAMEL FROM THE MASTICATING SURFACE OF A MOLAR.

The figure is merely intended to show the general direction of the fibres.

Fig. 90.

CAVITIES IN HUMAN ENAMEL

Which communicate with the dentinal tubes.

situated on the most prominent part of the crown, are arranged in a vertical direction; those upon the side are placed horizontally, whilst the intermediate fibres present all degrees of obliquity. As these fibres necessarily diverge from the dentinal to their free surface, the upper space thus occasioned must be filled by the gradual enlargement of the fibres from within outward or by the addition of supplemental fibres.

The latter assumption Mr. Tomes thinks the correct one, although difficult of demonstration. The enamel rods are marked by transverse striæ, which indicate, according to Mr. Beale, the successive layers of calcification, and are much more strongly pronounced in some specimens than in others, being most markedly so in the enamel of unhealthy subjects.

Upon opening a dental sac from a fœtal jaw, interposed between the inner surface of the sac and the coronal surface of the tooth, a semi-fluid, gelatinous substance will be found, composed of nucleated cylindrical columns with more or less spherical nucleated cells enveloped in fluid. Similar columns will be found on the inner surface of the sac. This is the

enamel organ, or enamel pulp, and from it the cells found in the gelatinous fluid have become separated. Columns of a like kind are also found on the surface of the enamel. When the tooth makes its way through the gum, and before it has suffered from friction, by the action of hydrochloric or acetic acid, a membrane-like surface may be raised from the surface of the enamel, which is seen under the microscope to consist on one side of "columns of the enamel pulp, and on the other of decalcified enamel fibres," joined end to end, but easily separated at the point of junction.

This membrane, to which Mr. Nasmyth first drew attention, is described as the persistent dental capsule; but Mr. Huxley thinks it is identical with the membrana præformativa.

The enamel differs from dentine in its greater density; the much earlier period at which entire calcification takes place; the absence, except in abnormal conditions, of any uncalcified portions; the direction in which calcification progresses; and in the fact that it is the least constant of the dental tissues. In pathological conditions irregular cavities are sometimes found in the enamel near to the surface of the dentine, and in such cases the dentinal tubes may communicate with them (Fig. 92). In some cases the dentinal tubes may enter the enamel, but this condition is more common to some animals than to the human subject. "It is more frequently absent than present in the teeth of the class of fishes; it is wanting in the entire order Ophidia among existing reptiles; and it forms no part of the teeth of the Edentata, and many cetacea among mammals." (Owen's "Odontography," xxiv.)

Dentine.—With regard to the manner of the formation of the dentine, the first step in this process is the development of the odontoblasts, which have the same relation in the development of the teeth as osteoblasts have in the formation of bone. The odontoblasts are large nucleated cells, of elongated form, provided with numerous processes developed from the dentinal papilla, which at that early stage consists of fine fibrous tissue containing many cells. The odontoblasts send out processes, which, as they develop, become calcified externally, the calcified portion forming the dentine, and the uncalcified part the dentinal fibrillæ, and the lateral processes the branches of anastomosis through which the tubuli or canals of the dentine communicate.

The remains of the odontoblasts themselves form the investment of the pulp, situated between its nerves and vessels and the dentine, a cellular layer known as the *membrana eboris*, or ivory mem-

brane of Kölliker. (See Origin and Formation of the Teeth.) The dentine is deposited around the fibrils of the odontoblasts, the latter occupying a position nearly at right angles to the surface of the dentine, the deposition being in the protoplasm which is found in interspaces between the fibres. Lime salts being deposited in the protoplasmic basis-substance, the odontoblast, as the process of secretion proceeds, becomes enclosed in a thin spherule of formed material, known as "calcoglobulin,"* and the dentine substance or tissue assumes the form of a homogeneous mass, traversed by tubes which contain the dentinal fibrils.

The greater portion or body of every tooth is composed of dentine, which is a yellowish-white, semi-transparent, hard, elastic substance, and intermediate in consistence between the enamel and the cementum. In a normal condition the dentine is never exposed, being covered in the crown of the tooth by the enamel, and in the root by the cementum.

In a fresh specimen the human tooth is found to consist of 62 per cent. of its weight in organic salts, 28 per cent. of tooth cartilage (organic matter), and 10 per cent. of water.

Berzelius gives the following analysis of dentine:—

Calcium Phosphate,	62.00
Calcium Carbonate,	5.50
Calcium Fluoride,	2.00
Magnesium Phosphate,	1.00
Sodium Salts,	1.50
Gelatin and Water,	28.00

Von Bibra gives—

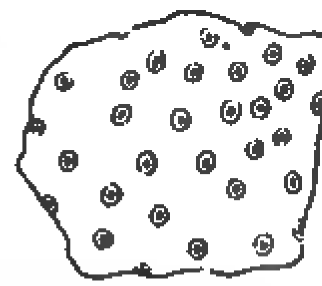
Calcium Phosphate and Fluoride,	67.54
Calcium Carbonate,	7.97
Magnesium Phosphate,	2.49
Salts,	1.00
Fat,	.58
Cartilage,	20.42

While the organic basis of the matrix of dentine is similar to that of bone, yet it is not identical, being of firmer consistence, and does

* Calcoglobulin is a term applied to a thin layer of partially calcified tissue, found between the organic and inorganic tissue in the development of bone, dentine, or cementum.

not yield gelatine when boiled. A fresh section of dentine presents a satiny aspect, but when submitted to the microscope it is found to consist of a multitude of fine tubes, known as the *dentinal tubuli*, with an *intertubular substance*. These minute tubes permeate the entire structure of the dentine, their direction varying in the different parts of the tooth. Each tube originates by an open, circular mouth or orifice upon the surface of the pulp-cavity, where it runs toward the periphery of the dentine in a direction usually perpendicular to the surface, just before reaching which it divides into branches.

Fig. 91.



TRANSVERSE SECTION OF DENTINE.

Proceeding in a wavy and radiated manner throughout every portion of the dentine to its periphery, these tubes, although generally terminating at that point, in some instances extend beyond

Fig. 92.

a c g

DENTINE AND CEMENTUM FROM THE ROOT OF A HUMAN INCISOR; COPIED FROM KÖLLIKER.

a, dentinal fibres or tubes; *b*, interglobular spaces, having the appearance of the *lacunæ* in bone; *c*, smaller interglobular spaces; *d*, commencement of the cementum, with numerous canals close together; *e*, its *lamellæ*; *f*, *lacunæ*; *g*, canals.

and encroach upon the enamel or upon the cementum. When the latter is the case, they may communicate with the canaliculi and lacunæ.

Toward the grinding surface of the crown of a tooth, when occlusion is received, these tubes have a vertical direction, and a horizontal direction when the pressure of adjoining teeth has to be

resisted; and thus the shock of occlusion and pressure is more generally distributed over the entire tooth structure. These dentinal tubes, instead of pursuing a straight course, describe curves, the longer ones less abruptly defined than the others, and are termed "primary curvatures," the latter being more common to the crown than to the root. The secondary curvatures, although smaller than the primary, are much more numerous. The coincidence of the primary curvatures of adjoining dentinal tubes, or the presence of rows of what are known as "interglobular spaces" (Fig. 92), may occasion a striated or laminated appearance of the dentine, the lines thus formed being at nearly right angles with the tubes and known as the *contour* lines of Owen. They proceed in an arched manner, somewhat parallel to each other.

The dentinal tubes are cemented together by a sub-granular matter, radiating from the cavity to the surface of the tooth. From these tubes branches are given off in great number in the roots and as the enamel approaches the dentinal surface. In the crown these branches are few in number. They anastomose freely with each other and with the superficial dental tissues. They terminate in loops or are lost in the enamel. By their extension into the superficial dental tissues a close union is formed between them and the dentine, notwithstanding the fact that each tissue is developed from a distinct formative pulp. Kölliker thought these tubes contained clear fluid in the fresh state. In the dried preparation they are empty, and are readily permeated by colored fluid. These facts give rise to the opinion, that their sole purpose was the conduct of nutrient fluids. Mr. Tomes, however, following Nasmyth, objected to this theory on purely physiological grounds. The extreme sensitiveness of an exposed coronal surface from which a portion of enamel has been broken; the fact that in operations for the removal of carious dentine the sensitiveness was found to be greatest just beneath the enamel; and furthermore, that when the pulp was broken up or destroyed by escharotics, this sensibility was lost, led him to conclude that the sensibility of the dentine depended on its connection with the pulp, and to suppose that these tube-contents might be in some

Fig. 93.

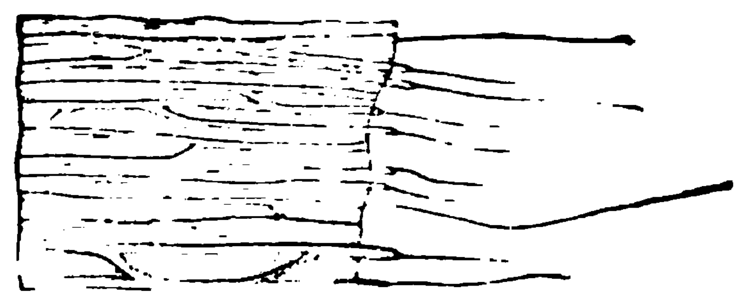
TERMINATION OF A DENTINAL TUBE IN THE MIDST OF THE DENTINE—HUMAN.

way associated with the sensibility of the structure in which they were found, serving to establish connection between it and the pulps, to which supposition fluid contents opposed an insurmountable difficulty. Led by this train of reasoning to a careful examination of the tubes, he found "each dentinal tube tenanted by a soft fibril, which, after passing from the pulp into the tube, follows its ramifications, and (Tomes's Dental Surgery, 327) that these fibrils may be traced into the dentinal pulps." Professor Kölliker and M. Lent had previously seen processes extending from the "peripheral cells of the dentinal pulp," but had supposed them "organisms for the development of the dentinal tubes." Mr. Tomes was unable to determine the manner in which the fibrils terminated in the pulp, whether by cells or by any communication with nerves; but does not, therefore, question the function he has assigned them, since, when their connection with the pulp is cut off, all sensibility is lost to the dentine. He adds: "It is by no means necessary to assume that the dentinal fibrils are actually nerves before allowing them the power of communicating sensation. Many animals are endowed with sensation which yet possess no demonstrable nervous system;" whilst, at the same time, it has been impossible to demonstrate nerves in the human body so numerous as to warrant the assumption that at every prick of a needle the point must touch a nerve fibre. Again, the greater sensibility of the dentine immediately beneath the enamel is satisfactorily accounted for by the law which refers to all nerves the greatest sensibility at their terminal extremities. Mr. Tomes also thinks "the foregoing facts will warrant the conclusion that the dentinal fibrils are subservient, not only to sensation in the dentine, but that they are also the channels by which the nutrition of this tissue is carried on," and argues very forcibly that they do convey nutrient fluids, from the fact that the tubes are capable of undergoing structural change, and that the fibrils may also become calcified at their distal extremities, and that the calcifying material

FIG. 94.

A FRAGMENT OF DENTINE, a, through which run the softer fibrils, c, which seem to be continuous with the odontoblast cells, b (after Dr. Lionel Beale).

FIG. 95.



SECTION OF DENTINE, From the edge of which hang out the dentinal sheaths, and beyond these again the fibrils (after Boll).

must be derived from the pulp, reaching the place of deposit through the fibrils. Differing in this from Dr. Beale, who, whilst agreeing with Mr. Tomes as to the presence of these fibrils, which he has himself succeeded in demonstrating, is of the opinion that the so-called dentinal tubes "are not tubes, nor are they canals for the transition of nutrient substances dissolved in fluids." He considers these fibrils as simple germinal matter communicating with the germinal matter on the surface of the pulp, and that the tubes are the formed material of this fibrillar germinal matter. "The wall of the tubes with the matter between the tubes corresponds to the 'wall' of an ordinary cell, or to this and the intercellular substance (my formed material), and the central parts of the contents with the nuclei (my germinal matter). If you look at the tissue of the pulp just beneath the surface of the dentine you find a number of oval masses of germinal matter colored intensely red by carmine. These are nearly equidistant, and separated from each other by a certain quantity of material which is very faintly colored, and in cases where the solution was not very strong it remained colorless. This colorless matrix is continuous with the intertubular or dentinal tissue, while the intensely red germinal matter, or, rather, a prolongation from it, extends to the dentinal tubes." (Beale on the Structure and Growth of Tissues, 155.) Dr. Beale admits that the dentinal tubes do convey nutrient fluids, but contends that they were not designed for that purpose. He says: "As in the formation of bone already described, spaces or pores are left, through which nutrient matter passes toward the germinal matter. In this way very fine channels result, which may be seen in the dry tooth passing from one dentinal tube to the other." (Structure and Growth of Tissue, 167.)

FIG. 96.

TRANSVERSE SECTION THROUGH THE DENTINAL TUBULI OF THE ROOT OF A HUMAN TOOTH. Magnified 850 diameters, showing their numerous anastomoses.

The dentinal fibrillæ appear to be formed by the peripheral portions of the processes of the odontoblasts, after the latter become long and narrow, attaining considerable length.

The formation of dentine begins about the fourth month of fœtal life, at the summit of the papilla. The superficial portion of the crown is first formed, and afterward undergoes no alteration in size, all subsequent growth taking place on the surface adjacent to the dentinal pulp. The growth of the root takes place from above,

downward into the aleveolus destined to receive it. Placed at right angles to the outer surface of the pulp, between it and the dentine already formed, or before any dentine is formed, is situated a layer of "elongated cylindrical bodies or cells, with nuclei" somewhat resembling nucleated, columnar epithelium. With regard to the exact share taken by the pulp in the formation of dentine, Kölliker says a layer of cells forming the peripheral portion of the pulp are immediately concerned in its formation. He says, that from the base of the dental sacs the *dental pulp* proceeds, rich in vessels, and finally also in nerves, with a non-vascular external portion. The latter is bounded by a delicate, structureless membrane, the membrana præformativa (Raschkow), which has no further relation to the formation of the tooth. Beneath this lie cells of 0.016 to 0.024''' in length, and 0.002 to 0.0045 in breadth, with very beautiful vesicular nuclei, and distinct single or multiple nucleoli. They are arranged close together over the whole surface of the pulp, like an epithelium, though not so closely defined as it would be, but gradually passing, at least apparently, by smaller cells into the parenchyma. In vascular pulps an additional boundary line may be traced, inasmuch as the capillary loops in which the vessels terminate do not penetrate between the cylindrical cells, but end close to one another upon their inner surfaces, so that, considering that the dentine is produced by the cells in question, we might be justified in terming them the *dentinal membrane* or *membrana eboris.* The internal portion of the pulp, he thinks, consists of a granular matrix, subsequently becoming more fibrous, and that when ossification of the dentine begins numerous vessels are developed, and a little later numerous nerves also make their appearance. According to this observer, it is "only the most external epithelium-like layer of cells," and not the entire pulp, which is engaged in the production of dentine, and these maintain a constant thickness "by the elongation of the original cells, accompanied by a continual multiplication of their nuclei." He does not consider that the "same cell suffices for the whole duration of the dentine," but that new cells may from time to time be formed; and denies that the whole pulp is progressively changed into dentinal cells, and thinks its only purpose is to support the vessels essential to the growth of the dentinal cells, from which alone the dentine is formed, by the gradual reception of calcareous salts. (From "Tomes's Dental Surgery," 388.)

M. Lent refers the formation of the dentinal tubes to a "series of delicate processes extending from the dentinal pulp," to which Köl-

liker assents, and thinks it probable that a single cell may generate an entire tube. He also recognizes the existence of an intertubular substance, which he believes to be "excreted by the cells in common, without structural relation to individual cells or their prolongation."

The theory advanced by Mr. Beale is, that on the dentinal surface of a tissue lying on the pulp are found certain "cells like columnar cells," which are in relation with the nerves and blood-vessels of the pulp into which they send prolongations, and that from these cells alone is developed the dentine, agreeing in so much with Kòlliker and Lent, but does not hold with them that the "canals are direct processes of the whole dentinal cells," nor that the intertubular substance is a direct secretion from the cells. His views are, briefly, that these cells or "elementary parts" are situated on the surface of the pulp; that they consist, as cells do everywhere, of germinal matter and formed material, and that the so-called intertubular substance is but the oldest part of the formed material, in which, by the gradual deposition of mineral matter, the dentine is formed; growth taking place here, as elsewhere, from within outward, from nuclei or germinal matter to cell-wall or formed material, while calcification takes place in the opposite direction, from the oldest and most distant formed material toward the germinal matter. We have said calcification takes place gradually, probably during the life of the individual or until the pulp-cavity is obliterated; hence we have a central mass of germinal matter, the so-called dental fibrils, surrounded by calcified formed material, giving rise to a tubular appearance, the dental tubes; and since the calcifying process takes place from without inward, the germinal matter is made to present the appearance of an attenuated fibre gradually enlarging as it approaches the pulp. Upon this fibrillar mass the calcifying process continually encroaches, until the so-called tube is obliterated. Until this is accomplished, however, the germinal matter must be nourished and mineral matter must be conveyed to its most distant part for deposition, and if this conduct of nutrient fluid constitutes a claim to the name, they may still be called tubes.

Notwithstanding Mr. Tomes's inability to trace any communication between this fibrillar matter and the nerves of the pulp, such connection must be supposed to exist—Prof. Christopher Johnston, of Baltimore, succeeded in tracing nervous communication with the dentine—and to it we must refer the sensibility of this tissue.

On account of the tubes dividing into minute branches, as they approach the surface of the dentine, they appear to end in very fine-pointed extremities. Some of these tubes anastomose with the branches of others, forming loops near the periphery, while others terminate deeper in the tissue. The inner walls of the tubes surrounding the fibrillæ constitute the dentinal sheaths, which are apparently of fibrous structure.

FIG. 97.

INTERGLOBULAR SPACES IN DENTINE.

The *intertubular tissue* contains the greater part of the earthy constituents of the dentine, and under the microscope presents a granular appearance.

What are known as *interglobular spaces* are indicators of arrested development of the dentinal tissue, and are not considered to be normal. These spaces are dark and irregular, and are most commonly observed a little distance below the surface in a discolored and imperfectly developed tooth; they have a ragged outline. According to Bödecker, soft, living plasm is found in the smaller interglobular spaces.

FIG. 98.

THICK LAMINATED CEMENTUM.
From the root of a human tooth.

According to Krause, dentine has a specific gravity of 2.080, and contains less earthy matter than the enamel, but more animal substance, which accounts for the rapid progress of caries when the dentine is exposed.

CEMENTUM.—Cementum is developed from the deeper tissues of the fœtal jaw, precisely like bone is produced in other parts of the body, by periosteal ossification. It contains canaliculi and lacunæ, and, according to Salter, Haversian canals in the thicker portion.

It is not so dense as the dentine, and approaches more nearly in

character true bone, which is necessary in order that the tooth may be tolerated by the more highly vitalized structures in relation with it.

The analysis of cementum is as follows: —

Calcium Phosphate and Fluoride,	58.73
Calcium Carbonate,	7.22
Magnesium Phosphate,	0.99
Salts,	0.82
Cartilage,	31.31
Fat,	0.93

The Cement, or *Crusta Petrosa*, is the most highly organized of the dental structures. It covers the roots of all the teeth, encroaching slightly upon the crown, where it overlaps the enamel. Its purpose is to bind the teeth securely in the alveoli, forming the vital bond between the bone and the commonly unvascular constituents of the teeth. It is thickest about the terminal part of the root, gradually thinning as it approaches the crown. According to Mr. Tomes, "its structural character depends upon the amount of tissue present." In the thicker parts the canaliculi are seen anastomosing freely with each other, and establishing vascular relations between the several lacunæ; and they "occasionally become connected with the terminal branches of the dental tubuli." This communication, though doubted by many observers, Mr. Tomes considers demonstrated "beyond cavil" by preparations in his possession. Haversian canals, as was before remarked, are also found in very thick sections of cementum; but M. Morel is of opinion that these canals are only found where cementum has been morbidly developed; but Mr. Tomes is of a different opinion, and says that where two roots are united by cementum a vascular canal will not unfrequently be found in it, and that this appearance "is not necessarily an evidence of disease." The lacunæ and canaliculi of cementum are distributed lengthwise around the root, those in proximity to the dentine joining with the terminal branches of the dentinal tubuli, while those upon the external surface radiate toward the investing membrane.

Fig. 99.

LACUNA OF CEMENTUM,
Which communicates with the termination of the dentinal tubes.

By such a provision, even after the devitalization and removal of the pulp, the vitality, not only of the cementum, but of the dentine of the teeth, is maintained.

From irritation of the dental periosteum the cementum often becomes hypertrophied, the affection being known as "dental exostosis." Cementum contains more animal matter than the dentine, and becomes very sensitive when exposed by the recession of the gum about the neck of the tooth.

OSTEO-DENTINE.—Osteo or secondary dentine is a substance partaking more of the nature of cementum than of ordinary dentine, as it possesses no true dentinal tubes, but canals similar to the canaliculi of bone. It is generally formed in the teeth of persons of advanced age, where the pulp-cavity is very much diminished in size, and it also forms a protection against the exposure of the pulp of the tooth which has been denuded of its natural tissues by mechanical abrasion, the action of caries, or by fracture. In other cases secondary dentine is deposited in isolated nodules scattered throughout the substance of the dental pulp, which may unite and form larger masses and become adherent to the walls of the pulp-cavity. Some of these masses are occasionally penetrated by blood-vessels and surrounded by concentric lamellæ, like the Haversian canals of bone.

FIG. 100.

SECONDARY DENTINE,

Filling up one of the cornua of the pulp cavity. From a human molar affected by caries.

The dividing line between the primitive and secondary formations of dentine is characterized by numerous irregular spaces and globular contours, while deeper in the mass of lately formed secondary dentine tubes or canals may exist.

Not infrequently, however, the tubuli of secondary dentine are arranged in a very irregular manner, either "in tufts or in bundles, and without any apparent reference to points of radiation." Osteo-dentine is also usually very transparent, on account of this tissue being devoid of light-refracting tubes, its canals being so completely filled up with the secondary deposit that they permit the transmission of light. The tubuli of normal dentine are frequently filled

with a secondary deposit, especially in the roots of teeth, and to which the name "horny dentine" has been given. The formation of secondary dentine appears to depend upon irritation of the pulp, of long continuance but restricted as to degree, and during the time "that the slow conversion of the organ is taking place the dentinal fibrillæ also become impregnated with calcareous matter and solidify."

PART SECOND.

DENTAL PATHOLOGY, THERAPEUTICS.

CHAPTER I.

GENERAL CONSIDERATIONS.

THE susceptibility of the human body to morbid impressions differs in different individuals. In some, its functional operations are liable to derangement from the most trifling causes; in others they are less easily disturbed. Nor do the same causes always produce the same results. Their effects are determined by the tendency of the organism and the susceptibility of the part on which they act; both with regard to constitutional and local disease, this is true of the organism generally, and of all its parts separately considered, but of none more than the teeth, gums and alveolar processes. The teeth of some persons are so susceptible to the action of corrosive agents, as to become involved in general and rapid decay as soon as they emerge from the gums; while those of others, though exposed to the same causes, remain unaffected through life. A similar difference of susceptibility also exists in the parts within which these organs are contained.

With the teeth these differences of susceptibility to morbid impressions are implanted in them at the time of their formation, and are the result of the different degrees of perfection in which this process is accomplished. In proportion as these organs are perfect, is their capability of resisting the action of destructive agents increased, and as they are otherwise, it is diminished. This is true of every part of the body; but as the teeth are formed, so they continue through life, if not impaired by disease, except that they gradually acquire a very slight increase of density, whereby their liability to caries is correspondingly lessened.

Not so, however, with the other parts of the body. They may be innately delicate or imperfectly developed, and afterward become firm and strong, or be at first healthy and well-formed, and subsequently become impaired; and in proportion as they undergo these changes, is their susceptibility to disease increased or diminished. But the teeth are not governed by the same laws, either physical or vital, that regulate the operations of the other parts of the animal economy. Not only the manner of their formation, but their diseases, also, are different. The other tissues of the body, not excepting the osseous, are endowed with recuperative powers, whereby an injury is repaired by their own inherent energies; but the teeth do not possess such attributes.

Assuming these propositions to be true—and that they are, especially those with regard to the teeth, we shall endeavor to show

—it becomes an object of considerable importance to discover the signs by which the susceptibility of the human organism to disease may be determined. But to do this, except in so far as the teeth, gums and alveolar processes are concerned, is not our present object; yet, in the prosecution of the task we have undertaken, we shall have occasion to advert to certain constitutional and local tendencies indicated by the appearance and condition of the teeth and other parts of the mouth.

M. Delabarre affirms that, by an inspection of the teeth, we can ascertain whether the innate constitution is good or bad, and our own observations go to confirm the truth of this opinion; but, as this author adds, these are not the only organs that should be interrogated. The lips, the gums, the tongue, and the fluids of the mouth, should also be examined, to discover the health of the organism, and ascertain whether the original condition of the constitution has undergone any change.

Those who have not been in the constant habit of closely observing the appearances met with in the mouth, may be skeptical with regard to the information that may thus be derived; but those who have studied them with care will not hesitate to say that they are, in many instances, more certain and accurate than any which can be obtained from other physical appearances. For example: the periods of the dentinification of the different classes of both sets of teeth being known, we are able to infer whether the innate constitution be good or bad, from the physical condition of these organs; for, as the functions of the organism are at this time healthily or unhealthily performed, will they be perfect or imperfect, or, in other words, will their texture be hard or soft.

It is well known to writers on odontology, that the teeth of the child, like other parts of the body, usually resemble those of its parents; so that when those of the father or mother are bad or irregularly arranged, a similar imperfection is generally found to exist in those of the offspring; but this does not necessarily follow, and when it does, it is the result of the transmission of some constitutional impairment, whereby the formative operation of these organs is either disturbed or prevented from being effected in a perfect and healthy manner. The quality of the teeth of the child, therefore, may be said to depend on the health of the mother, and the aliment from which it derives its subsistence. If the mother be healthy, and the nourishment of the child of good quality, the teeth will be dense and compact in their texture, generally well-formed and well-arranged, and as a consequence less liable to be acted on by morbid secretions than those of children deriving

their being from unhealthy mothers, and subsisting upon aliment of a bad quality. Temperament, also, exercises an influence upon the functional operations of the body.

The Temperament in Relation to the Teeth.—Before proceeding further, it may be well to notice the individual conditions or qualities known as temperaments. The word temperament is derived from the Latin *tempero*, "to mix together," and implies the constitution as determined by the predominance of certain constituents of the body. For among the ancients it was supposed that the manifestations of the functions were tempered or so determined by the predominance of any one of the three humors then recognized, namely: blood, lymph, bile, and atrabilis, or black bile. Dunglison, in his Medical Dictionary, defines the temperaments to be those individual differences which consist in "such disproportion of parts, as regards volume and activity, as to sensibly modify the whole organism, but without interfering with the health;" in other words, a physiological condition in which the functions of the different organs are so regulated as to impress certain characteristics upon each individual. Others contend that these individual differences, "though they can scarcely be called morbid, yet certainly give a proclivity to disease in the direction indicated by the temperaments."

Dr. James W. White, on this subject, remarks: "Temperament may be defined as a constitutional organization, depending primarily upon heredity—national or ancestral—and consisting chiefly in a certain relative proportion of the mechanical, nutritive, and nervous systems, and the relative energy of the various functions of the body—the reciprocal action of the digestive, respiratory, circulatory, and nervous systems. The stomach, liver, lungs, heart, and brain—digestion, assimilation, respiration, circulation, and innervation—are all factors in the differentiation of temperament; and according to the congenital predominance of one or the other, and the relative activity of these functions, is the modification of the characteristics of the individual which determines his position as to temperament. Each temperament is the result as well as the indication of the preponderance of one or another of these systems, and of relative functional activity.

"A perfect equilibrium of the different systems is rarely if ever presented in any individual. One having a balance of all the temperaments would be temperamentless, or of no special temperament. It is difficult, in some cases, to decide positively to which variety a special case belongs, the several temperaments being combined and blended in such ever-varying proportions. Not infrequently the indications are even contradictory, and the blending of several tem-

peraments requires a nice discrimination to define the admixture. The primary elements of temperament are susceptible of such manifold combinations; the determining forces are so complex, and our knowledge of their comparative values is so limited, that no rule can be given which will not fail in numerous instances to apply in all respects to individual cases; but that there is a general relation between constitutional qualities and external signs does not admit of question.

"Temperaments are readily divisible into four basal classes—bilious, sanguineous, nervous, and lymphatic; then again into sub-classes of mixed temperaments—a combination of two or more of the primary divisions. In these combinations one or other of the so-called basal temperaments predominates, and a compound term is used to express the complexity, as, for instance, the nervo-bilious, signifying that the bilious base—the foundation temperament—is qualified by an admixture of the nervous element, and so throughout the series. Twelve varieties of temperament, in addition to the four basal, may thus be designated by the combination in pairs of the original four. The admixture of the peculiarities of three or of all four of the basal temperaments results in what are denominated respectively ternary and quaternary combinations, which call for nice discrimination in diagnosis; but even such complexities are registered in the size, form and color of the dental organs."

The *sanguineous* temperament is characterized by a fair, ruddy complexion, yellow, red or light auburn, or light-brown hair, a good class of teeth, a full muscular development, large, full veins and active pulse, indicating an abundant supply of blood, and warm extremities, all showing perfect health, and in females a tendency to voluptuousness. The mind is hopeful and elastic, yet at the same time fickle and volatile, with little determination and perseverance. Although indicating perfect health, yet in this temperament diseases are prone to assume the acute form, and speedily run their course either to recovery or a fatal termination.

The *bilious* temperament is characterized by a preponderance of bile, indicated by a dark or sallow countenance, black hair, generally luxuriant, a slow or moderate circulation of the blood, shown by a hard, strong pulse, dark eyes, strong teeth, with a yellow tinge over the entire crown; and the body, instead of the roundness of form peculiar to the sanguine temperament, is angular; wanting in ease and grace of manner; there is restlessness, but at the same time great force of character and quickness of perception and power of will. The digestive organs, however, are more liable to derangement than in other temperaments, indicating some defective action

in these organs; the liver, of course, being the principal one affected, and necessitating the use of mercury as a stimulus.

The *lymphatic* temperament is characterized by a predominance of lymph or phlegm in the system; and persons possessing it have a general softness or laxity of the tissues, the proportion of the fluids being too great for that of the solids, the lymphatics and absorbents not acting so thoroughly as to prevent the cellular tissue from being filled with humors; so that there is a want of sensibility. The complexion is fair, but not ruddy, and the hair, either light or dark, is not luxuriant, but thin and straight. The eyes are light, generally blue, the circulation feeble, and the pulse, as a consequence, weak, and a want of tone in the system. The skin is pale, flabby, and moist, and the body is heavy and rounded, while the teeth, although they may often appear comparatively good, yet are sensitive and not highly organized. Although the expression denotes a want of activity, yet there is a clear and active mind, characterized by prudence and sound judgment without enthusiasm. Owing to the predominance of lymph, there is a tendency to dropsy and chronic disease.

The *nervous* temperament is characterized by the predominance of the nervous element, and by great activity or susceptibility of the great nervous centre—the brain. Persons possessing this temperament are distinguished by their impressibility, susceptibility to intense feeling or intense excitement. There is great irritability, anxiety, and agitation, which peculiarities enable us readily to recognize it by the tone of voice and manner of speaking. The body is slender, though well formed, the complexion pale and soft, and the muscles small and yielding. In illness, symptoms are often complicated with those of nervous disorder, and the mind desponding. There is want of power and endurance.

Upon the temperament the constitutional health depends to a greater extent than pathologists generally admit; and hence it is that that of the child usually partakes of that of one or other, or both, of its parents. "This," says M. Delabarre, "is particularly observable in subjects that have been suckled by a mother or nurse, whose temperament was similar to theirs." To obviate the entailment of this evil, he recommends mothers having teeth constitutionally bad to abstain from suckling, and that this highly important office be intrusted to a nurse having good teeth; asserting at the same time, that by this means the transmission of so troublesome a heritage as bad teeth may be avoided.

Dr. J. Foster Flagg gives the following tabular presentations of the relation of the temperament to the teeth:—

THE TEETH AS INDICATED BY TEMPERAMENT.

GENERAL DIVISIONS.	BILIOUS.	SANGUINEOUS.	NERVOUS.	LYMPHATIC.
General Color and Quality of Color	Bronze-yellow, with strength or power of coloring.	Cream-yellow, and inclined to translucency.	Pearl-blue or gray; inclined to transparency.	Pallid and opaque, or muddy in coloring.
General Form	Large and inclined to angular; rather long in proportion to breadth.	Well proportioned; abounding in curved or rounded outlines; cusps rounding.	Length predominating over breadth; fine, long, cutting edges and cusps.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the Teeth	Inclined to transverse ridges, and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Smooth, or nearly so; elevations and depressions rounded; cutting edges and cusps translucent. Fair degree of brilliancy.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surface of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting edges.
Articulation	Firm and close; well locked.	Moderately firm; jaw inclined to rotate in mastication.	Very long and penetrating.	Loose and flat.
Gum Margin or Festoon	Heavy and firm, but inclined to angularity.	Round and full, as regards both breadth and depth.	Delicate, shapely, and fine; oval in curve.	Thick and undefined in shape.
Rugæ	Heavy and rugged in shape; squarely set.	Numerous and graceful in outline; not heavy, but well rounded.	Close, not numerous; small and long.	Sparse and flat.

Depending, then, as the physical condition of the teeth and the organism generally confessedly do, upon the quality of the nourishment from which subsistence is derived during infancy and childhood, it is highly essential that this be good; and that that especially, derived from the breast, be from those only who are in the enjoyment of perfect health and possess good constitutions.

The teeth, while in a pulpy state, partake of the health of the organism generally. As that is healthy and strong, or unhealthy and weak, so will the elementary principles of which they are then composed be of a good quality, or deteriorated; but after dentinification has commenced, the solid parts cease to be influenced by, or to obey the laws of, the other parts of the body. If the general health be good at the time this process is going on, it will be evidenced by their density and color; if bad, in the looseness of their texture, etc.

This is a subject to which we have paid some attention, having for a long time been in the habit of carefully noting the differences in the appearance of the teeth of different individuals and of both dentitions; and, though we have been able to conjecture in some instances what had been the state of the mother's health during the first months of pregnancy, candor compels us to confess that we have never been able to find any signs in the peculiarity of their shape, size, density, or arrangement that indicated it. But from the moment that the part of the formative process of these organs which is not influenced by subsequent changes in the general economy commences, certain peculiarities of appearance are impressed upon them that continue through life, and about the certainty of the indications of which, in regard to the general health, we think there can be no doubt.

With regard to the information concerning the innate constitution to be derived from an inspection of the teeth, it has been well remarked by Delabarre, that physicians may derive much advantage in pointing out the rules of domestic hygiene for the physical education of children; for, says this eminent dentist, "Can he admit of but one mode? Has he not, then, the greatest interest in being well assured of the innate constitution of each child for whom advice is required, to enable him to recommend nutriment suited to the strength of its organs? Will he report only on a superficial examination of the face, its paleness, the color of the skin, all of which are variable? Will he not regard the repletion or leanness of the subject, the state of the pulse, etc.? Surely he will make good inductions from all these things; but the minute examination of the mouth will give him beyond doubt the means of confirming his judg-

ment; for, besides what we already know of the teeth, the mucous membrane of the buccal cavity receives its color from the blood, and varies according to the state of that fluid." This is a matter which the observation of the dentist has an opportunity of confirming almost every day; and which, when taken in connection with the physical characteristics of the teeth, together with those of the salivary and mucous secretions of the mouth, constitute data from which both the innate and present states of the constitutional health may be determined with accuracy and certainty.

The symptoms of actual disease have been minutely and repeatedly described, but the physiognomical signs by which the susceptibility of the human organism to morbid impressions is determined, and the kind of malady most likely to result therefrom, do not appear to be so well understood. "Whatever," says the author last quoted, "may be the knowledge which a practitioner may acquire of the changes which a disease, or even any tendency to disease, may effect in the functions of some organs, it is, at least, advantageous to be able to conjecture what has happened in the whole of the system at some other time. In fact, can a physician, when about to prescribe for a slight indisposition of a person whom he hardly knows, rely entirely upon the symptomatology of the tongue? Do not its aspects singularly vary? Is it not notorious that in certain persons it is always red, white, yellow, or blackish? I, as well as others, have had occasion to make these observations on persons with whom it was always thus, yet without their being subject to any of those indispositions that are so common in the course of life." The signs are as variable in sickness as in health, and, consequently, can only be relied upon as confirmatory of the correctness of other indications which manifest themselves in other parts of the body.

The physical changes produced by, and characteristic of, disease have been described, both by ancient and modern medical writers; but the works which have appeared upon this subject do not comprise all that is necessary to be known. For example, if we examine the lips, tongue and gums of a dozen or more individuals who are regarded as in health, differences in their appearance and condition will be found to exist. The lips of some will be red, soft, and thin; others, red, thick, and of a firm texture; some will be thin and pale; others, red on the inside and pale on the edges; some are constantly bathed with the fluids of the mouth; others are dry; and these differences of appearance and condition are as marked on the tongue and gums as they are upon the lips, and are supposed to be attributable to the preponderance of want of existence in suf-

ficient quantity of some one or more of the elementary principles of the organism. Hence may be said to result the differences in temperament and susceptibility of the body to the action of morbid excitants.

If the quality and respective proportions of the materials furnished for the growth, reparation and maintenance of the several organs of the body be good, and in proper proportion, all the organs will be well formed and endowed with health, and, as a consequence, capable of performing their respective functions in a healthy manner. But if their elementary ingredients, to use an expression of the author from whom we have just quoted, be bad, their functions will be more or less feebly performed.

These materials are furnished by the blood. From this fluid each organ receives such as are necessary to its own particular organization. The blood, therefore, exercises an important influence upon the whole system, determining the health of all its parts, which, as Delabarre says, "is relative to the quantity of the blood, and the general health results from that of all parts of the system." In order to do this, harmony must exist between all the organs; but in consequence of the great variety and intermingling of temperaments, it rarely does, except, perhaps, in those in whom the sanguine predominates, and who have not become enervated by irregular and luxurious living. Even when it does exist, we are by no means certain that it will continue to do so; for, exposed, as the body is, to a thousand causes of disease, its functional operations may, at almost any moment, become disturbed. Among the civilized nations of the earth, the peasantry of Great Britain probably possess as good constitutional temperaments as are anywhere to be found; and yet, with these people, we are told, that although the sanguineous predominates in a majority of cases, it is combined and intermingled, in a greater or less degree, with others.

In all these modifications the blood plays an important part; it determines the temperament of the individual, and, by consequence, the physical condition of all the tissues of the body subject to the general laws of the economy. But the dependence between the solids and this fluid is mutual; it, also, is dependent upon them, and the condition of one is relative to that of the other. The solids, if we may be permitted the use of the metaphor, are the distillery of the fluids, while they, in turn, nourish, repair, and maintain the solids. A change, then, in the condition of one is followed by a corresponding change in the condition of the other. If the blood be of an impure quality, or any of the ingredients entering into its composition exist in too great or too small a quantity, it will fail to

supply the solids with the materials necessary to the healthful performance of their functions, and, if not actual disease, a tendency to it, will be the result. And, again, the purity of the blood is dependent upon the manner in which the solids perform their offices. While, therefore, duly appreciating the importance of this fluid, and its existence in a pure state, to the general health of the economy, we cannot ascribe to it, regardless of the functions of the solids, a controlling influence over the organism.

To distinguish all the nice and varied shadings of temperament, or states of the constitutional health, by the physiognomical appearances of the body, is perhaps impossible, or can only be done with great difficulty, and by those who have been long exercised in their observance; but to discover that which predominates is not so difficult a matter, and the indications are nowhere more palpably manifested than in the mouth. By an inspection of the several parts of this cavity, together with the fluids and the earthy matter found upon the teeth, we believe inductions may be made, not only with regard to the innate constitution, but also with regard to the present state of health, serviceable both to the dental and medical practitioner; and, in the further prosecution of this inquiry, we shall endeavor to point out some of the principal of the indications here met with, to state the appearances by which they are distinguished, and to offer such other general reflections as the subject may, from time to time, seem to suggest.

CHAPTER II.

DENTITION.

THE term "dentition" implies the eruption of the teeth, and is a process which consists of two stages, namely, first dentition and second dentition. At about the seventh week of intra-uterine existence the process of development of the teeth of first dentition begins, and shortly after birth the outlines of the forms of the deciduous teeth may be observed on the external aspect of the jaws; but as age advances, owing to the increased development of the mucous membrane and alveolar processes, these outlines become less apparent. As the period of dentition approaches, a slight ridge on the summit of each jaw is seen, which is attributed to the dipping down of the process of epithelium which forms the enamel organ. Prior to the sixth month of age (first dentition commencing generally

between the fifth and seventh months after birth), small prominences are observed on the summits of the alveolar processes, which gradually become more distinct and almost as light in color as the teeth themselves. As soon as the tooth has penetrated the mucous membrane, the latter contracts so as to permit the crown of the tooth to project above its level.

The deciduous teeth begin to erupt between the fifth and seventh months, and at the age of two years and a half all of the first set have appeared, the corresponding teeth of the two sides of the jaw erupting at the same time. The two inferior central incisors appear at the age of six or seven months, in the order in which they are named, followed by the superior central incisors, the superior lateral incisors, the inferior lateral incisors, the four first molars, the four canines, and last, the four second molars. The usual order of the eruption of the deciduous teeth is as follows:—

Central incisors	between	the	5th and 8th	months.
Lateral incisors	"	"	7th and 10th	"
First molars	"	"	12th and 16th	"
Cuspids	"	"	14th and 20th	"
Second molars	"	"	20th and 30th	"

The lower teeth generally precede the upper teeth by a few weeks, appearing in the same order.

This order, however, is not invariably followed, for teeth may be prematurely erupted so as to be seen at birth. But the cases of retarded eruption are much more common than those of premature eruption, owing to constitutional debility or the existence of some constitutional disease.

During the eruptive period, there is a gradual elongation and protrusion of the teeth, and a coincident dissolving away of both the hard and soft tissues which overlie them. The approximal edges of the alveolar borders of the maxillary bones disappear by an absorptive process, the teeth rise in their cavities, and their roots lengthen to such a degree that the crowns press upon the opposing gums, which, under such pressure, become thinner and thinner, until finally the crowns escape.

Henry Sewell, M.R.C.S., gives the following concise description of the process of eruption: "The eruption of the teeth is a process of gradual elongation of the teeth on the one hand, and the simultaneous absorption of the super-imposed tissue on the other. The absorption commences, first, in the overhanging margins and front walls of the alveoli, which gradually disappear until room is afforded for the passage of the advancing tooth. The growth of the tooth keeps pace with this absorption, and the crown of the tooth at length pressing

against the membranous coverings, these undergo atrophy, and becoming by degrees thinner, and at last transparent, give way and disclose the advancing crown."

The exact relation of dentition to infantile diseases is not generally recognized, and many affections have been erroneously ascribed to this process.

There is no doubt, however, that the condition of the system at the period of first dentition is such that the infant is very susceptible to nervous impressions, and hence the symptoms of any constitutional disease that may be present are greatly aggravated.

Owing to the predominance of the nervous system in infancy, there is a greater sympathy between distant organs than in adult life, and considerable disturbances may be excited early in life by even slight functional disorders. The brain is proportionally larger and less perfect in structure than in the adult; the tissues of the body are also softer and more vascular, the skin is more sensitive, the abdomen, glands, kidneys, liver, pancreas and lacteal vessels, are disproportionately large, and functional activity depends chiefly upon the nutritive processes. Such peculiarities, therefore, account for the susceptibility to disease in infants and the tendency of their diseases to become inflammatory, and to involve organs not originally affected.

The evolution of the teeth is commonly attended with more or less inflammation of the parts in relation with the dental follicles, and this turgescence is greater with some teeth than with others; sometimes it is present to such a degree that the gums are greatly swollen and extremely tender, presenting a very red appearance, more so than in ordinary dentition.

The indications of the eruption of the teeth are an increased flow of saliva, which tends to keep the mouth moist and cool, and is due to the irritation of the trifacial nerve which gives sensation to the teeth and nutrition to the salivary glands; an itching of the mouth which causes the infant to keep its fingers on the gums, as a slight pressure evidently gives some relief; the irritation continuing, the mouth, as a result, becomes hot and dry, and there is more or less febrile excitement. Diarrhœa frequently ensues, which, if not too great, is beneficial; one or both cheeks may become unusually red, which is a symptom of nervous disturbance; eruptions may appear on the face or head, and sometimes on the entire body; ulcerations may occur on the lips, gums, inside of the cheeks, and on the tongue; itching of the nose, twitching of the muscles, disturbed sleep, wakefulness, dilatation of the pupils, thirst, loss of appetite, all indicate an increase of the irritation; the temper becomes very

irritable, and delay in the eruption of a tooth may cause congestion of the gum with swelling of the cheek; nausea and vomiting, diarrhœa, fever, thirst, and other system disturbances, such as convulsions, etc., may soon succeed these symptoms. A premature eruption of the teeth is more liable to give rise to constitutional symptoms than a tardy or delayed eruption.

The salivary secretion, which is very scanty prior to the period of the eruption of the teeth, always increases as dentition approaches, and in cases of difficult dentition, becomes very profuse. A decided form of stomatitis may be present, and in some cases, even abscesses have formed, which could only be relieved by incisions. As a general rule the degree of irritation present depends upon the number of teeth erupting, but owing to the difference of susceptibility, one tooth may give rise to more irritation than the simultaneous eruption of several teeth will in other cases.

A perfectly healthy child, properly cared for, may erupt its teeth with little or no suffering, although there may be some restlessness, a slight decrease of appetite, and a slight elevation of the temperature of the mouth. At other times a mere local uneasiness may be experienced, which will induce the infant to place its finger in the mouth, or to bite upon some foreign substance, which apparently affords relief. In such cases as these the processes of the development of the teeth, and the absorption of the tissues confining them, are equal, and the result is that the teeth perforate the gum without causing either pain or irritation. Where, however, there is a difference in the progress between the growth of the teeth and the absorption of the opposing structures, then these different forces produce irritation, and a difficult dentition results.

When the eruptive period arrives, the roots of the teeth are yet incomplete, for instead of a conical end and the small opening or foramen which a completed tooth presents, there is a voluminous pulp occupying a cavity with an incomplete termination almost as large as the root itself; hence any considerable increase of vascular and nervous action produces a hyperæmia of the pulp which may cause its protrusion and induce thereby constitutional disturbance.

The immediate cause of the irritation is conceded to be due to the downward pressure of the root upon the nerves and vessels of the pulp of the tooth, such pressure being caused by the opposing gum, and giving rise to congestion and swelling, which have the effect of increasing the induration of the opposing tissues. Constitutional as well as local symptoms result from such irritation, some of which are of the most serious character. The cerebro-spinal system may become affected, giving rise to restlessness, sleeplessness, pain in the

head, convulsions or paralysis; also the respiratory system, a condition which is manifested by cough, catarrh, bronchitis, pneumonia, or spasmodic croup; also the alimentary canal, where there may be nausea, vomiting, loss of appetite or diarrhœa; also the skin may become affected, and such forms of skin disease may manifest themselves as eczema, acne, etc. Therefore, the period of dentition may be a dangerous one, for many infants die at this time, either from convulsions, from whooping cough, or cholera infantum. Difficult dentition is more frequently a predisposing than a direct cause of infantile convulsions. At such a period a sensitive state of the nervous system, or an afflux of blood to the head, may result in convulsions, although such an affection may be the direct consequence of the irritation caused by the efforts of several teeth to erupt at the same time, especially in the case of weakly children.

The premonitory symptoms of convulsions are depression, restlessness, and fretfulness for some days before the paroxysm; the eyes have a wild, unnatural appearance, the sleep is disturbed, and sometimes there is unusual heat of the head, with a sudden starting or twitching of the limbs. In general convulsions, the paroxysm is characterized by a hot head during its early stage, and a flushed face, while in sympathetic convulsions the head is cool and the face pallid; the pulse is accelerated, as well as the respiration, which is also irregular, especially if the respiratory muscles are involved, which is usually the case. The muscles of the face, eyes and eyelids, and limbs, are in a state of rapid involuntary contraction and relaxation; the features are distorted; the mouth is drawn out of shape, and the teeth become tightly closed, owing to the tonic contraction of the masseter muscles; and if the paroxysm is prolonged, frothy saliva may issue from the lips.

The eyelids are usually open, and in severe cases the pupils of the eyes are concealed under the upper lids, or the eyeballs may be forcibly drawn from side to side. The head is strongly retracted, or turned to one side; the thumbs and fingers are convulsively flexed, so that the former are turned across the palms and covered by the fingers; the great toe is adducted and the other toes are flexed, and with the legs move spasmodically; consciousness is lost. The duration of the paroxysm varies from a few minutes to several hours, generally averaging from five to fifteen minutes; and when it terminates favorably, the spasmodic movements gradually cease, and are followed by a deep inspiration and quiet or sleep, with a return of consciousness. The temperature and respiration become natural, although dullness and bewilderment of mind may continue for several hours. In severe cases, the respiration is so embarrassed

and the circulation so retarded that congestion of various organs results. Death does not usually occur from one paroxysm, but from several at intervals, during the last of which convulsive movements cease, and there is no return of consciousness; the limbs grow cold, the pulse feeble, and coma supervenes.

The treatment of convulsions consists in first removing the irritation by the use of the gum-lancet, by emesis, purgatives, etc., according to the indications; the feet, as soon as possible, may be put in hot water, to which mustard is added; or a warm bath may be used; such measures have a soothing effect upon the nervous system, and cause muscular relaxation and derivation of blood from the cerebro-spinal axis. They also prevent passive congestion and œdema of the brain and lungs. Antispasmodics and nervous sedatives are indicated after the cause of the irritation has been removed. Cold applications, in the form of a cloth frequently wrung out in cold water, should be made to the head, to reduce its temperature, which will have the effect of contracting the vessels and membranes of the head, and diminishing the cerebral congestion. An aperient is useful, unless there has been previous diarrhœa. An enema of soap and water will produce free and speedy evacuation, as it is often necessary to relieve the digestive canal of irritating substances.

For the relief of the paroxysm, and to lessen its duration, chloroform has been successfully employed as an anæsthetic, but as it is a dangerous agent, the bromide of potassium is preferable, in doses of three grains for a child one year of age, or four or five grains for a child of two or three years of age, dissolved in cold water, and administered every ten minutes; after the convulsions cease, there should be longer intervals between the doses. In very severe cases, where the bromide of potassium may not act with the required promptness, the hydrate of chloral may be employed in doses of five grains for a child of one year of age, and ten grains for one of four years of age, dissolved in two or three drachms of water, and injected, by means of a small syringe, into the rectum. The bromide of potassium may be combined with the chloral as follows: ℞. Potassii bromid. gr. xvj; Chloral. hydrat. gr. iv to vj; Sodii bicarb. gr. xv; Aquæ menth. pip. f℥j. M.

This remedy is generally successful in controlling the spasmodic movements in five or ten minutes, unless recovery is impossible. During such premonitory symptoms of difficult dentition as fretfulness and nervous excitement, the bromide of potassium is a useful and safe remedy. Demulcent and soothing lotions are useful to reduce the swelling and tenderness of the gums; and an ivory or rubber ring, for the child to bite upon, will afford great relief.

The practice of rubbing the gums with a thimble or ring is injurious, as the swelling and tenderness are increased.

Unless the tooth is on the point of protruding, the operation of lancing the gum is by many thought to be unnecessary, for the reason that the gum is not rendered tense by the pressure of the advancing tooth, and too much importance has been attached to the supposed tension and resistance of the gum.

When the symptoms are local and the gums are somewhat congested and swollen, scarifying them lightly with a very sharp lancet will often afford relief; but if the gums are very tender, this operation should not be performed.

Others, again, advocate the operation of lancing the gums in difficult dentition, even when no single local indication exists in the mouth, by making free incisions over the teeth whose eruption is anticipated, the cuts extending through the gum to the presenting surface of the tooth, and thus affording manifest and complete relief. No injury results to the erupting tooth, or to the germ of the developing permanent one, if the lancet is carried to the surface of the crown, without undue force is employed. Partially erupted canines and molars sometimes require the use of the lancet to relieve the pressure of the enclosing band of gum tissue. Such objections against lancing the gums, as the infliction of great pain and uncontrollable hemorrhage, are of little moment, as is also the assumed increased resistance of cicatricial tissue; for, although the wound made by the lancet should heal before the appearance of the tooth, this cicatricial tissue is easier absorbed, and consequently less resistant.

For lancing the gum over an incisor, a single incision in the line of the arch will answer; the molars generally require a crucial incision, and the gum of the canines, even after the point of the cusp has emerged, may require severance on the lateral, anterior and posterior surfaces, in order to relieve the tension and liberate these teeth. The illustrations (Fig. 101) show the necessary incisions for the different classes of teeth. Should undue bleeding result from such an operation, it can be arrested by means of a little finely powdered alum applied to the incisions; should such a remedy fail, more powerful astringents or styptics can be employed, such as tannic acid, styptic colloid, matico, powdered resin, etc. Nitrate of silver and the iron preparations are liable to cause slough and secondary hemorrhage; hence should never be employed in such cases. As the act of sucking may promote persistent bleeding, in such cases the child should be either placed at the breast of the nurse, or a gag of soft linen be introduced in such a manner as will

prevent the infant from sucking its gums. Internal remedies in case of a hemorrhagic diathesis are indicated to correct an abnormal or depraved condition of the blood and promote contraction of the orifices of the bleeding vessels; but their use is seldom necessary.

When such remedies are indicated, tincture of the muriate of iron, acetate of lead, aromatic sulphuric acid, gallic acid, and tur-

Fig. 101.

pentine are the agents to be employed. Dr. James W. White gives the following formula which will meet all the indications in such cases:—

℞. Tinct. ferri chloridi, ... f ʒ ss.
Acid. acetic. dil., ... f ʒ j.
Liq. ammonii acet., ... f ʒ j.
Ext. ergot. fld., ... f ʒ ij.
Syr. simp., ... f ℥ ss.
Aquæ, ... q. s. ad f ℥ iij. M.

Dose, a teaspoonful every three hours for a child six months old.

It is not unusual for some children to be affected with diarrhœa during the period of dentition, and which may be accompanied with irritability of the stomach. Where not too debilitating and protracted, the diarrhœa is beneficial, but, on the other hand, it must not be neglected and permitted to become a source of danger. But there are often other causes for this affection than those which can be attributed to dentition, such as improper food and clothing, residence in unhealthy localities, and exposure to cold.

The diarrhœa, when severe, should be controlled by proper remedies, capable of reducing the number of evacuations to two or three daily, as a greater number may result in danger to the child. The treatment of the diarrhœa of dentition consists in a change in the diet, the adoption of hygienic measures, and, when medicines are necessary, the administration of the milder purgatives in small

doses. Where the dejections are acid, as is shown by the green color, half a teaspoonful to one teaspoonful of castor oil or calcined magnesia will prove beneficial. According to Dr. West, if there be neither much pain nor tenesmus, and the evacuations, though watery, are fecal, and contain little mucus and no blood, very small doses of the sulphate of magnesia and tincture of rhubarb are more useful than any other remedy.

℞. Magnesiæ sulphatis, ... ʒj.
Tinct. rhei, ... ʒj.
Syr. zingiberis, ... ʒj.
Aquæ carui, ... ℥ix. M.

Sig.—One drachm three times a day, for children one year old.

Dr. Christopher Elliott recommends half to one drachm doses of the infusion of chamomile-flowers for infantile diarrhœa of dentition, when the evacuations are greenish in color or are slimy and streaked with blood.

For the diarrhœa of infants due to indigestion, and attended with acidity, Prof. J. L. Smith recommends the following:—

℞. Pulv. ipecac., ... gr. ss.
Pulv. rhei, ... gr. ij.
Sodæ bicarb., ... gr. xij. M.

Divide into chart. No. xij. One powder every four to six hours, for an infant one year old.

The same author also recommends the following in the non-inflammatory diarrhœa of infants:—

℞. Tinct. opii deodorat., ... gtt. xvj.
Bismuth. subnitrat., ... ʒij.
Syr. simplic., ... ℥ss.
Mistur. cretæ., ... ℥iss. M.

Shake well, and give one teaspoonful, from three to four hours.

For increased excitability of the intestine due to dental irritation, which is indicated by frequent stools of semi-solid matter containing undigested food, Dr. Lees recommends the use of bromide of potassium in from three to five-grain doses every three or four hours for a child one year of age. Persistent constipation may be treated with ten-drop doses, three times daily, of cod-liver oil, increasing the dose if necessary to a half drachm.

For the skin affection attending dentition, such as eczema in the acute form, with a watery discharge and an irritable skin, oxide of zinc, used as a dusting powder, will prove serviceable, but the parts should not be washed with water.

When the discharge is thicker and more purulent, and forms scabs, they may be removed by bathing the part with oil and washing it with soap and water, and a salve applied, composed of equal parts of vaseline and simple lead plaster; or less of the lead plaster may be used with the vaseline, if the salve should prove too strong; or an ointment may be employed, composed of oxide of zinc, five grains, and simple salve, one ounce.

When the gum over an erupting tooth appears swollen and congested, and at length ulcerates, even after the tooth is protruding, a condition to which the appellation "odontitis infantum" has been applied, the ulcers may be touched with a crystal of alum, and a lotion composed of sage tea and honey used, with decided advantage. For a sloughing condition of the mucous membrane over an erupting tooth, the careful application of strong carbolic acid will prove efficient.

During infancy, and especially during the period of dentition, the clothing should consist of fine, soft flannel next to the skin, to protect the body from variations of temperature, and all changes be made gradually. The food for some months after birth should be confined exclusively to milk, that of the mother being preferable when she is in good health. For artificial food, when such is necessary, an excellent preparation is that of Dr. J. F. Meigs, which consists of equal parts of milk, cream, lime-water, and oatmeal, barley- or arrowroot-water, to which a little sugar of milk is added.

SECOND DENTITION.

The design of nature is to preserve the deciduous teeth until their roots are absorbed and they become loose, and are removed to make room for their permanent successors. But the eruption of the permanent teeth begins before any of the deciduous teeth are removed. Between the ages of five and a half and six years, the first permanent molars make their appearance; hence they are commonly called "sixth-year molars," and their germs, with those of the remaining permanent teeth, are progressing with the development of the deciduous teeth.

When the permanent teeth are developing, and their crowns, on account of the growth of the roots, are approaching the alveoli of the deciduous teeth, a process of absorption commences, by which the roots of the latter teeth are gradually destroyed, the dissolving process going on until only the crowns of the deciduous ones remain. The process of absorption affects the roots of the deciduous teeth in the order corresponding to their development and eruption; the inferior central incisors are first shed, then the superior central incisors, then

the lateral incisors; and this order is preserved until all of the deciduous teeth have been removed or have become so loose that they are easily extracted.

The absorptive process commences in the alveoli of the deciduous teeth, and then attacks the apices of their roots, and in some cases progresses until it involves a large portion of the crowns. The loss of substance commences generally upon the side of the root, near the apex, toward the advancing crown of the permanent tooth, and the surface of the root acted upon presents pits, grooves, or irregular facets, with rough surfaces and sharp edges, such as would result from corrosion. If a deciduous tooth undergoing this process of absorption be extracted, a loose, spongy substance is

FIG. 102.

ILLUSTRATES THE JAWS OF A CHILD BETWEEN SIX AND SEVEN YEARS OF AGE, SHOWING THE RELATIONS OF THE TWO SETS OF TEETH.

found adherent to it, which Laforgue and Bourdet supposed to be an absorbent organ secreting a fluid capable of dissolving the tooth-structure. According to Wedl, a fluid is secreted by the cells of this organ which dissolves the hard substance, and referring to the theory held by some, he says "that these cells are of a parasitic nature, that is to say, that the dental substances are eaten up, as it were, since the cells absorb the latter, and he remarks that "possibly amœboid movements may be the occasion of the wasting of the tissues;" he is also of the opinion that the organ of absorption is developed from the connective tissue of the root membrane of the deciduous tooth. According to a microscopic examination made

by Mr. Tomes, the surface of this absorptive organ is made up of peculiar multiform cells, each one being composed of several smaller cells, the number varying from two or three to as many as fourteen or fifteen.

Some have regarded the method employed by nature for the removal of the roots of the temporary teeth as *sui generis*, but there is a better reason for considering it to be the effect of an inflammatory process that brings about a proliferation of cell-growth, which may at one time act as an absorbent and at another be reparative. As to the precise manner in which these cells of the absorbent organ act, much remains to be learned, but that it is a physiological process, and occasioned by the action of cells known as "osteoclasts," or "odontoclasts," and is not a mechanical force, is now quite generally admitted. These cells secrete what has been termed "a soluble ferment," or "fluid of exudation," which dissolves out the lime salts from the hard tissues with which it comes in contact, the surface acted upon presenting a series of pits and cup-shaped depressions.

Dr. C. N. Peirce, in an excellent article, entitled "Calcification and Decalcification of the Teeth,"* and which is illustrated by the following instructive figures (Fig. 103), in treating of the absorption or decalcification of the roots of the deciduous teeth, regards this process "as being both physiological and somewhat obscure," and he further states:

"The evidence that it is the result of a physiological action is the fact that it matters not to what extent absorption has progressed, the very moment vitality of the pulp ceases that instant this retrograde metamorphosis terminates. What induces this molecular dissolution it is difficult to state, though the several conditions which are always present are readily recognized; but the part they play is so obscure that it is not readily ascertained. The manner of its commencement when successful—always at the end of the root—and the presence of a vascular papilla in close proximity to the absorbing surface, are, with the retention of pulp vitality, three essential accompaniments, and the absence of any one of them would militate against the completion of the process.

"The statement that the presence and pressure of the permanent tooth are essential, cannot be sustained, for frequently the decalcification of the deciduous tooth is successfully accomplished in the absence of its successor; and again, how often do we find the permanent tooth impacted against or within the bifurcated roots of

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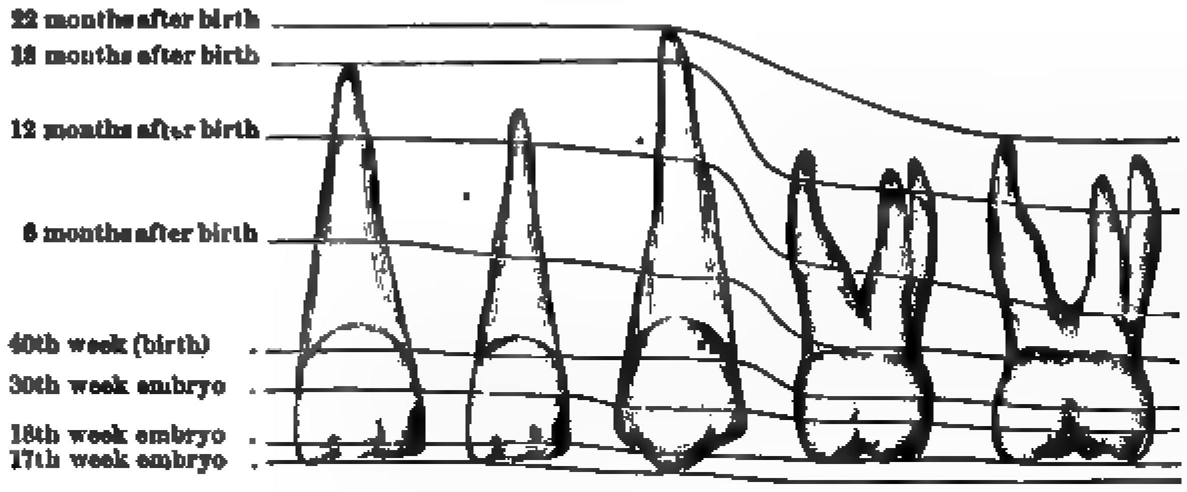
* Dental Cosmos, August, 1884.

Fig. 108.

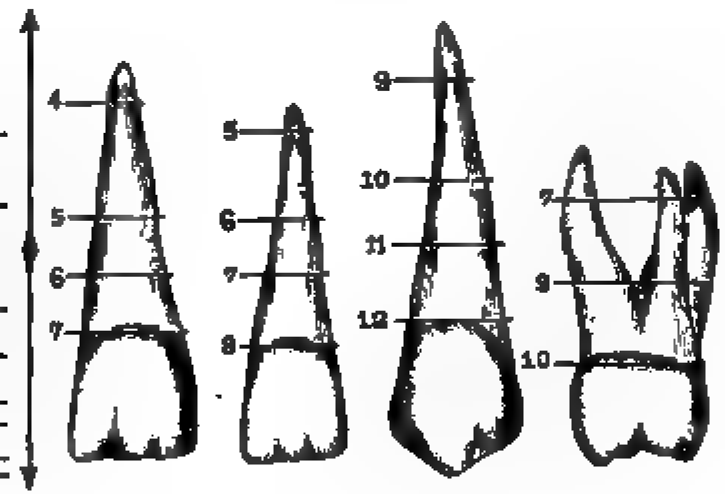
CALCIFICATION AND DECALCIFICATION OF THE TEETH.

Fig. 1.



Calcification of the Deciduous Teeth.

Fig. 3.



Decalcification of the Deciduous Teeth.
The numbers on Fig. 3 indicate years.

Calcification of the Permanent Teeth.

From a Paper by Dr. C. N. Peirce, in the Dental Cosmos for August, 1884.

the deciduous molar, or pressing down by the side of its single-rooted predecessor, both being more or less displaced by the persistence of the deciduous tooth without absorption. That the organ has served its purpose, and that the nourishment which had previously been appropriated by it is diverted or relegated to its successors, is probably the most plausible explanation we can give of this interesting physiological process."

The average time and order for the eruption of the permanent teeth are as follows:—

First molars,	5 to 6 years.
Central incisors,	6 " 8 "
Lateral incisors,	7 " 9 "
First bicuspids,	9 " 10 "
Second bicuspids,	10 " 12 "
Canines,	11 " 18 "
Second molars,	12 " 14 "
Third molars, or wisdom teeth,	17 " 21 "

Usually little or no difficulty attends the eruption of the permanent teeth, with the exception of the third molars of the lower jaw, which may cause considerable trouble and suffering, on account of their being crowded between the second molar and the ramus or ascending portion of the jaw, the space left being insufficient to accommodate the third molar. Inflammation from such a cause may extend to the soft tissues, such as the muscles, and render the act of swallowing difficult and painful, and that of mastication impossible. The inflammation thus caused may also terminate in suppuration, and the pus discharge at remote points, internal or external. Such maladies as neuralgia, hysteria, epilepsy, St. Vitus' dance, disordered vision, earache, deafness, tetanus, etc., have been caused by the eruption of the third molar. Occasionally the eruption of the molars anterior to the third molars may be attended with some constitutional disturbance, such as headache, slight neuralgic pains, impaired appetite; and also local symptoms, such as swollen gums, increased heat of mouth, and an increased flow of saliva. The extraction of the third molar may be necessary in some cases; in others, that of the second molar, although the removal of a carious first molar may sometimes relieve the crowded condition of the arch, when the trouble is owing to a want of space between the second molar and the ramus of the jaw. The lancing of the gum over a third molar not yet protruded often relieves. The most common period of suffering from second dentition, apart from that of the third molar, is from the tenth to the thirteenth year, and it is

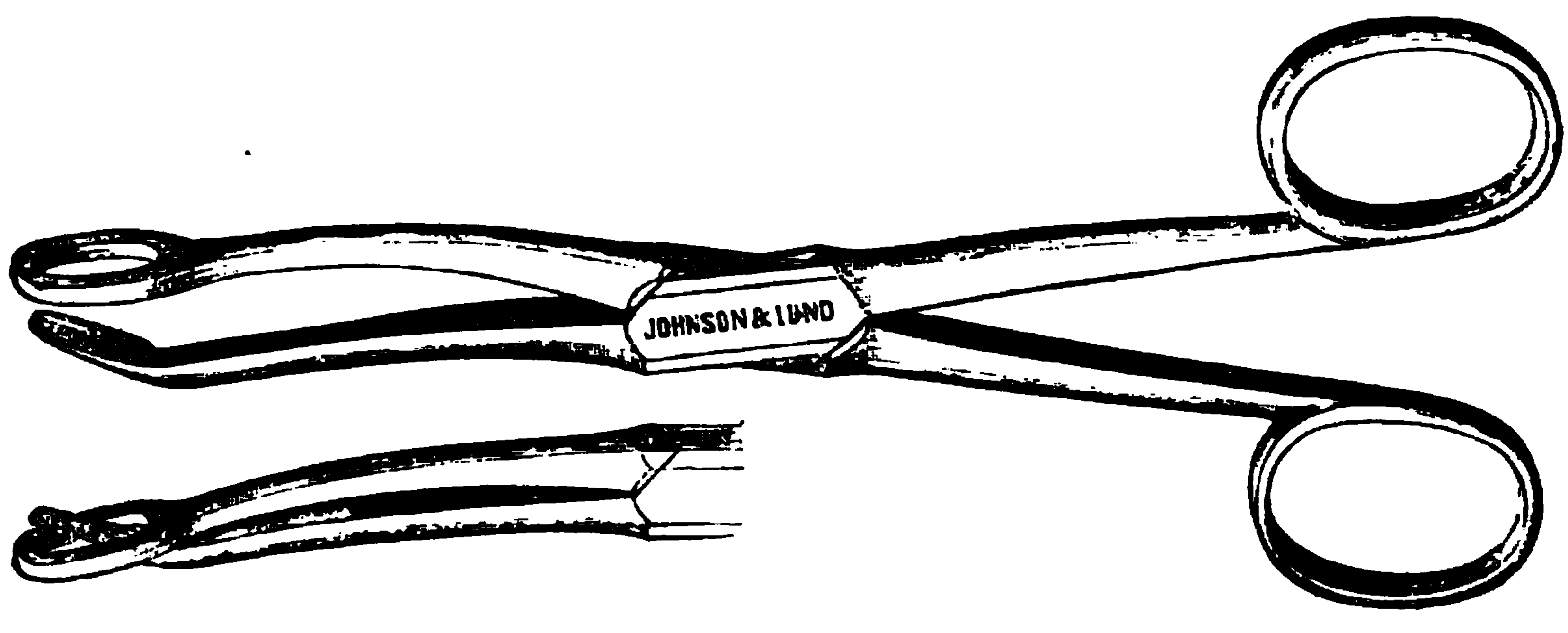
characterized by such affections as obstinate and protracted cough, with paroxysms of long duration, also diarrhœa, wasting of flesh, nervous diseases, loss of spirits, headache, and morbidly sensitive and painful eyes.

The obstinate cough has disappeared when the molar teeth pierced the gums; and a mixture of iron and nitric acid was successful in immediately curing a patient of seven years of age in the practice of Dr. James Jackson, who recommends the following remedies as being most useful:—

"First, a relief from study or from regular tasks, yet using books so far as they afford agreeable occupation or amusement. Second, exercise in the open air, preferring the mode most agreeable to the patient, and in more grave cases the removal from town to country."

Fig. 104 represents an instrument, the invention of Mr. Woodhouse, and introduced by Dr. L. D. Shepard, designed for the removal

Fig. 104.



of the overlying gum which covers the masticating surfaces of the first and third molars, very often for months after the cusps have appeared through the gum, and thus promotes, if it does not cause, the decay so frequently accompanying these teeth upon their eruption. An incision is made with a lancet, through the gum, along the anterior margin of the tooth, and the thin flat blade of the cutter is inserted; then, by closing the handles, the section of gum the size of the blade is instantly removed. The operator will find this process much more effectual, and far easier to the patient, than the usual practice of cutting the gum in different directions.

THIRD DENTITION.

That nature sometimes makes an effort to produce a third set of teeth is a fact which, however much it may be disputed, is now so well established, that no room is left for cavil or doubt.

The following interesting particulars are taken from "Good's Study of Medicine":—

"We sometimes, though rarely, meet with playful attempts on the part of nature to reproduce teeth at a very late period of life, and after the permanent teeth have been lost by accident or by natural decay.

"This most commonly takes place between the sixty-third and eighty-first year, or the interval which fills up the two grand climacteric years of the Greek physiologist, at which period the constitution appears occasionally to make an effort to repair other defects than lost teeth. . . .

"For the most part, the teeth, in this case, shoot forth irregularly, few in number, and without proper roots, and, even where roots are produced, without a renewal of sockets. Hence, they are often loose, and frequently more injurious than useful, by interfering with the uniform line of indurated and callous gums, which, for many years, perhaps, had been employed as a substitute for the teeth. A case of this kind is related by Dr. Bisset, of Knayton, in which the patient, a female in her ninety-eighth year, cut twelve molar teeth, mostly in the lower jaw, four of which were thrown out soon afterward, while the rest, at the time of examination, were found more or less loose.

"The German Ephemerides contain numerous examples of the same kind; in some of which teeth were produced at the advanced age of ninety, a hundred and even a hundred and twenty years. One of the most singular instances on record is that given by Dr. Slade, which occurred to his father, who, at the age of seventy-five, reproduced an incisor, lost twenty-five years before, so that, at eighty, he had hereby a perfect row of teeth in both jaws. At eighty-two they all dropped out successively; two years afterward they were all successively renewed, so that at eighty-five he had once more an entire set. His hair, at the same time, changed from a white to a dark hue; and his constitution seemed, in some degree, more healthy and vigorous. He died suddenly, at the age of ninety or a hundred.

"Sometimes these teeth are produced with wonderful rapidity; but in such cases with very great pain, from the callosity of the gums through which they have to force themselves. The Edinburgh Medical Commentaries supply us with an instance of this kind. The individual was in his sixty-first year, and altogether toothless. At this time his gums and jawbones became painful, and the pain was at length excruciating. But within the space of twenty-one days

from its commencement, both jaws were furnished with a new set of teeth, complete in number.

A late physician of Baltimore informed the author, in 1838, that an example of third dentition had come under his own observation. The subject, a female, at the age of sixty, he assured him, erupted an entire new set in each jaw.

The following extract of a letter from a professional friend,* describes another very interesting case:—

"I have just seen a case of third dentition. The subject of this 'playful freak of nature,' as Dr. Good styles it, is a gentleman residing in the neighborhood of Coleman's Mill, Caroline County, Virginia. He is now in his seventy-eighth year, and, as he playfully remarked, 'is just cutting his teeth.' There are eleven out, five in the upper and six in the lower jaw. Those in the upper jaw are two central incisors, one lateral and two bicuspids, on the right side. Those in the lower are the four incisors, one cuspid and one molar. Their appearance is that of bone, extremely rough, without any coating or enamel, and of a dingy brown color."

Two cases somewhat like the foregoing have come under the author's observation. The subject of the first was a shoemaker, Mr. M., of Baltimore, who erupted a lateral incisor and cuspid at the age of thirty. Two years before this time he had been badly salivated, and, in consequence, lost four upper incisors and one cuspid. The alveoli of these teeth exfoliated, and at the time he first saw him were entirely detached from the jaw, and barely retained in the mouth by their adhesion to the gums. On removing them, he found two white bony protuberances, which, on examination, proved to be the crowns of an incisor and cuspid. They were perfectly formed, and though much shorter than the other teeth, yet up to 1845 they remained quite firm in the jaw.

The subject of the other case was a lady residing near Fredericksburg, Virginia, who erupted four right central incisors of the upper jaw successively. One of her temporary teeth, in the first instance, had been permitted to remain too long in the mouth, and a permanent central incisor, in consequence, came out in front of the dental arch. To remedy this deformity, the deciduous incisor was, after some delay, removed; and about two years after, the permanent tooth, not having fallen back into its proper place, was also extracted. Another two years having elapsed, another tooth came out in the same place and in the same manner, and, for similar reasons, was also removed. To the astonishment of the lady and her friends, a

* Dr. J. D. McCabe.

fourth incisor made its appearance in the same place, two years and a half after the extraction of the first permanent tooth. When it had been out about eighteen months, the author was called in by the lady, who wished him, if possible, to adjust it. Finding that it could not be brought within the dental circle, he advised her to have it extracted and an artificial tooth placed in the proper place in the arch.

In the second number of the eighth volume of the "American Journal of Dental Science," the history of a case of four successive dentitions of the upper central incisors is given.*

The following interesting case is related by Dr. B. H. Catching in the *Southern Dental Journal* for October, 1886. The patient was a girl, born August 6th, 1871, very small and delicate, having been a six-months' child.

At the age of six months the eruption of the teeth began, and at seven months she possessed a full set of diminutive teeth, all of which were shed within three months. When eleven months old, teeth again began to erupt, and at the age of fifteen months a second full set was in her mouth. These soon crumbled away, and her mouth was without teeth until she had arrived at the age of two and a half years, when a third set began to erupt. The child weighed at this time but ten pounds, and this third set of teeth caused her so much trouble that the mother endeavored to have them extracted, and not being able to induce a dentist to perform the operation, she extracted twelve of the teeth herself in order to give relief to her child; and all of the third set were removed prior to her fourth year of age. She remained without teeth until her eleventh year, when her last and permanent set began to erupt; nearly all of which were, at the date of writing this account, in her mouth, sound and firm. Her last set is deficient in one superior central incisor, one superior left bicuspid, two inferior right bicuspids, and an inferior left cuspid and bicuspid. At seven years of age this child weighed but thirty pounds, but at fifteen years of age she had developed into a stout, strong girl. Dr. T. T. Moore, of S. C., verifies this case, as the child was under his care also, both himself and Dr. Catching having carefully observed the conditions and development from the beginning to the end.

Concerning the manner of the origin and formation of teeth of third dentition, adopting Wedl's views, germs may lie dormant for many years in the animal organism, until they are subjected to favorable conditions which enable them to develop. The crowns of

* Dr. W. H. Dwinelle.

such teeth only being formed, while the roots are stunted, is clearly due to the small depth of the jaws in old age.

CHARACTERISTICS OF THE TEETH.

Most dental physiologists have observed the marked differences that exist in the appearances of the teeth, gums, lips, tongue, and secretions of the mouth of different individuals; and of that earthy substance (commonly called tartar), deposited in a greater or less abundance on the teeth of every one; and, although all may not have sought their etiology, many have had occasion to notice, at least, their local indications, and to profit by the information which they have thus obtained. Nor have they failed to observe that the size, color, length and arrangement of the teeth vary, and that these are indications of their susceptibility to disease.

There are five principal classes or descriptions of teeth, each of which differs, in some respects, from the others, a knowledge of which is very essential to the dental practitioner, in order that he may determine their liability to decay, strength of attachment, and the form and size of their roots.

Class First.—The teeth belonging to this class are white, with a light cream-colored tinge near the gum, which becomes more and more apparent as the subject advances in age, of a medium size, rather short than long, with thick, square edges; those of each class of uniform dimensions, and very hard. This description of the teeth is most frequently met with in persons of sanguineous temperament, or, at least, those in whom this predominates; they rarely decay, and generally occupy their proper position in the dental arch; the most common deviation, and one most peculiar to this class, is that of the superior incisors antagonizing with the inferior, causing the form of abrasion known as mechanical. They are not as easily acted upon by corrosive agents, and caries attacking them, usually of the black variety, makes but slow progress, and often exists for a considerable time without causing pain or inconvenience. Operations performed upon teeth of this class are those, above all others, on which we can predict the most perfect success. They indicate, if not *perfect* health, at least a state which bordered very closely on it at the time of their dentinification.

This first description of teeth is occasionally found among persons of all nations. They are very common in cold and temperate climates, and especially in the middle classes of the inhabitants of England, Ireland, and Scotland. They are also frequently met with in some parts of the United States, the Canadas, the mountainous districts of Mexico, and, so far as we have had an opportunity of

informing ourself, in France, Russia, Prussiá, and Switzerland. Those who have them usually enjoy excellent health, and are seldom troubled with dyspepsia or any of its concomitants. It is this kind of teeth which Lavater says he has never met with except in "good, acute, candid, honest men," and of whose possessors it has been remarked, that their stomachs are always willing to digest whatever their teeth are ready to masticate.

In confirmation of what has before been said with regard to the influence which the state of the constitutional health at the time of the solidification of the teeth exerts upon the susceptibility of these organs to morbid impressions, it is only necessary to mention the fact, well known and frequently alluded to, of the early decay of a single class, or a pair of a single class of teeth, in each jaw, while the rest, possessing the characteristics just described, remain sound through life. Thus, when it happens that a child of excellent constitution is affected with any severe disease, the teeth which are at the time receiving their earthy salts are found, on their eruption, to differ from those which have received their solid material at another time, when the operations of the body were healthfully performed. Instead of having a white, smooth, and uniform surface, they have a sort of chalky aspect, or are faintly tinged with blue, and are rougher and less uniform in their surfaces. Teeth of this description are very susceptible to the action of corrosive agents, and, as a consequence, rarely last long.

But, not willing to rest the correctness of these views upon mere hypothesis, we, in a great number of instances, where we have seen teeth thus varying in their physical appearance, have taken pains to inquire of those who had an opportunity of knowing the state of the general health of the individuals at the different periods of dentinification; and in every case where we have been able to procure the desired information, it has tended to the confirmation of the opinion here advanced. Nor have we neglected to improve the many opportunities that have presented, in the course of a somewhat extended professional career, of making these observations.

Although the operations of the economy are so secretly carried on that it is impossible to comprehend their details fully, it is known that the phenomena resulting therefrom are influenced and modified by the manner in which they are performed. If they are deranged, the blood, from which the earthy materials forming the basis of all the osseous tissues are derived, is deteriorated, and furnishes these salts in less abundance and of an inferior quality. Hence, teeth that solidify when the system is under the influence of disease, do not possess the characteristics necessary to enable them to resist the

assaults of corrosive agents, to which all teeth are more or less exposed, and which rarely affect those that receive their solidifying ingredients from pure blood.

The calcareous salts of these organs are furnished chiefly by the red part of this fluid, the gelatine is derived from the white or serous part; "whence," as Delabarre remarks, "it results that the solidity of these bones varies according as one or other of these principles predominates," and the relative proportions of these are regulated by the state of the blood at the time the teeth are undergoing solidification.

Class Second.—Having digressed thus far, we shall now proceed to notice the teeth belonging to the second class. They have a faint, azure-blue appearance; are rather long than short; the incisors are generally thin and narrow, the centrals being frequently a little longer than the laterals. In some cases the lateral incisors are very small and pointed. The cuspids are usually round and pointed; the bicuspids and molars small in circumference, with prominent cusps and protuberances upon their grinding surfaces.

Teeth possessing these characteristics are usually very sensitive, caused, doubtless, by a superabundance of animal matter, and are more easily acted upon than teeth of the first class by corrosive agents, and to the ravages of which, unless great attention is paid to their cleanliness, they often fall early victims. The variety of caries almost peculiar to this class is known as the white, the parts attacked being rendered soft and humid; and as they retain their natural color, it but too frequently happens that such teeth are almost irretrievably ruined before its presence is suspected. They are, also, more frequently affected with atrophy, or have upon their surfaces white, brown, or opaque spots, varying in size and number; several are sometimes found upon a single tooth, and in some instances every tooth in the mouth is more or less marked with them.

But this is not the only description of teeth liable to be affected with this disease. These spots are occasionally met with on teeth of every degree of density, shape, shade, and size; but they are, probably, more frequently seen on teeth of the second class than on those first described; besides which, it often happens that they are affected with erosion on emerging from the gums, and sometimes so badly as to place either their restoration or preservation beyond the reach of art. This species of erosion, or that which occurs previously to the eruption of the teeth, is caused by some diseased condition of the fluid which surrounds them before they appear above the gums, and is denominated congenital.

Teeth like those now under consideration are indicative of a

weakly constitution, of a temperament considerably removed from the sanguineous, resembling the lymphatic, and of blood altogether too serous to furnish materials such as are necessary for building up a strong and healthy organism. They are more common to females than to males, though many of the latter have them. They are met with among people of all countries, but more frequently among those who reside in sickly localities, and with individuals whose systems have become enervated by luxurious living. In Great Britain they are more rare than in the United States, and those who have them seldom attain to a great age. Nevertheless, some, under the influence of a judicious regimen and a salubrious climate, though innately delicate, do acquire a good constitution, and live to a great age; while the teeth less fortunate, unless the most rigid and constant attention is paid to the use of the means necessary for their preservation, generally fall early victims to the ravages of disease.

Class Third.—The teeth of this class, though differing in many of their characteristics from those last described, are, nevertheless, not unlike them in texture and sensibility to disease. They are peculiar to those who have inherited a scrofulous habit or diathesis. In this state of the system we find a sufficient supply of blood, but it is usually of a pernicious character; the whole organism is affected by it and rendered very susceptible to disease, more especially to that class superinduced by cold. Teeth developed under constitutional defects of this nature are larger than teeth of the first or second class; their faces are rough and irregular, with protuberances arising, not only from the grinding surfaces of the biscupids and molars, but also not unfrequently from their sides, with correspondingly deep indentations. They have a muddy white color. The crowns of the incisors of both jaws are broad, long, and thick. The posterior or palatine surfaces of those of the superior maxilla are rough and usually deeply indented. In the majority of cases their arrangement is quite regular, though frequently found to project. The alveolar ridge usually describes a broad arch. The excess in size, both here and in the teeth, seems to consist more of gelatin than calcareous phosphate. Teeth of this description decay rapidly, and in some instances appear to set at defiance the resources of the dentist. They are liable to be attacked at almost every point, but more particularly in their indentations and approximal surfaces. The caries to which these teeth are liable is in color and consistence between the two kinds mentioned in connection with the first and second classes.

The author is acquainted with a family, consisting of seven or

eight members, most of whom are adults, all having this sort of teeth. The most thorough attention has been paid by each, and yet all have lost most of their teeth. They are usually first attacked in their approximal surfaces and indentations, but neither their labial faces nor most prominent points are exempt from caries. No sooner is its progress arrested in one place or part than it appears in another. The author has had occasion to fill a single tooth in as many as four, five, and even six different places; and in this way, though his efforts at the preservation of any considerable number have proved unavailing, he has been able to save some of them. But it is not necessary to particularize cases. Every dentist has seen teeth of this description.

The corrosive properties of the fluids of the mouth, however, are sometimes so changed by an amelioration of the constitution that, notwithstanding the great susceptibility of the teeth to disease, they are sometimes preserved to a late period of life, or until the general health relapses into its former or some other unfavorable condition. This has happened in several instances that have come under the author's immediate observation, and it should be borne in mind that the solvent qualities of these juices are influenced by the state of the constitutional health.

Class Fourth.—Teeth of this class usually have a white, chalky appearance, are unequally developed, and of a very soft texture. They are easily acted upon by corrosive agents, and, like the teeth last noticed, generally fall speedy victims to disease, unless great care is taken to secure their preservation.

Persons who have teeth such as described in this class, generally have what Laforgue calls lymphatico-serous temperaments. Their blood is usually pale, the fluids of the mouth abundant, and for the most part exceedingly viscid. They do not have that white, frothy appearance observable in healthy, sanguineous individuals.

As teeth that are neither too large nor too small, and that have a close, compact texture, and tinged with yellow, are indicative of an originally good constitution, whatever it may be at the present time, so those that are long, narrow, and faintly tinged with blue, as well as those that greatly exceed the ordinary size, and that are irregular in shape, and have a rough, muddy appearance, furnish assurance of a constitution originally bad. The first of the latter descriptions of teeth are more frequently met with among females than males, and among those of strumous habit, than those in whom this diathesis does not exist.

Class Fifth.—The teeth belonging to this class are characterized by whiteness and a pearly gloss of the enamel. They are long and

usually small in circumference, though sometimes well developed. They are regarded by many as denoting a tendency to phthisis pulmonalis, and are supposed by some to be very durable; but the author has observed that individuals who have this sort of teeth, when attacked by febrile or any other form of disease having a tendency to alter the fluids of the body, are very subject to toothache and caries; and that when this condition of the general system is continued for a considerable length of time, the teeth, one after another, in rapid succession, crumble to pieces.

It would seem, from this circumstance, that the fluids of the mouth in subjects of strumous habit, if free from other morbid tendencies, are less prejudicial to the teeth than they are in most other constitutions, and the author is of the opinion that it is owing to this that they are so seldom attacked by caries.

M. Delabarre, in speaking of persons who have teeth which, though beautiful, from having smooth and apparently polished surfaces, present shades intermixed with a dirty white, says, they "have had alternations of good and indifferent health during the formation of the enamel. These teeth," he continues, "ordinarily have elongated crowns, and many present marks of congenital atrophy." Again he observes, "Teeth of this sort deceive us by appearing more solid than they are; they remain sound until about the age of fourteen or eighteen; at this period a certain number of them decay, especially when in infancy the subject was lymphatic, and continued to be so in adolescence. This description of teeth is frequently met with among the richer classes, in which children born feeble reach puberty only by means of great care, and, consequently, owe their existence solely to the unremitting attention of their parents and the strengthening regimen that the physician has caused them constantly to pursue. Having reached the eighteenth or twentieth year, their health is confirmed, but the mucous membranes ever after have a tendency to be affected; the redder color of the mouth, more especially its interior part, and that of the lips, and the upper part of the palate, which, by degrees, discovers itself as the subject gradually advances in years, showing an ameliorated condition. It is thus that numerous persons, having gained a sanguineous temperament, would deceive us, if it were not that some marks of erosion are seen on the masticating surfaces of the first permanent molars, which informs us that the present health is the result of amelioration."

There are other cases in which the teeth are of so inferior a quality that they no sooner emerge from the gums than they are attacked and destroyed by caries, while the subjects who possess them are

enabled, by skillful treatment, to overcome the morbid constitutional tendencies against which, during the earlier years of their existence, they had to contend, and eventually to acquire excellent health. But in forming a prognosis, it is essential to ascertain whether the general organic derangement which prevented the teeth from being well formed, and thus gave rise to their premature decay, is hereditary, or whether it has been produced by some accidental cause subsequent to birth. The procurement of health in the former case will be less certain than in the latter, for when the original elements of the organism are bad, the attainment of a good constitution is more difficult.

Persons of sanguineo-mucous temperaments, having suffered in early childhood from febrile or inflammatory diseases, often have their teeth affected with what Duval calls the decorticating process (denudation of their enamel), resulting, no doubt, from the destruction of the bond of union between it and the dentine.

There are other characteristics which the teeth present in shape, size, density, and color, and from which valuable inductions might be made, both with regard to the innate constitution and the means necessary to their own preservation; but as the limits assigned to this part of our subject will not admit of their consideration, we shall conclude by observing that the appearances of these organs vary almost to infinity. Each is indicative of the state of the general health at the time of their formation, and of their own physical condition and susceptibility to disease.

CHAPTER III.

DISEASES OF MUCOUS MEMBRANE.

STOMATITIS.

The diseases of the mucous membrane lining the mouth, very common at the periods for the eruption of the teeth and later in life, are comparatively rare during fœtal life, and differ, as regards symptoms, in accordance with the nature of the affection and the part of the mucous surface in which it may have its origin.

The most common affection of the membrane lining the mouth is known by the general term *stomatitis*, from the Greek word στομα, "mouth," and *itis*, a "suffix denoting inflammation," and is described by Prof. Wood as follows:—

"Inflammation of the mouth appears in reddened, somewhat

elevated patches, or occupies large portions of the surface, sometimes extending apparently over the whole mouth. In some cases it is superficial, with little or no swelling, and may be designated as *erythematous*, from the Greek word ερυθρος, 'red;' in others it occupies the whole thickness of the membrane, extending sometimes to the submucous tissue, and even to the neighboring structures, as the sublingual and submaxillary glands, and the absorbent glands of the neck, and occasions considerable tumefaction in all these parts. In the erythematous form it is characterized by redness and sense of heat, and sometimes considerable tenderness, but is not usually attended with acute pain; when deeper in the tissue it is often very painful.

"Portions of the epithelium sometimes become opaque, giving an appearance of whiteness in streaks or patches. Occasionally this coating is elevated in blisters, or even detached, like the cuticle, from the skin, in scales. Superficial ulcerations not unfrequently occur, which may spread over considerable portions of the membrane. In certain states of the constitution the ulcerative tendency is very strong and deep, and extensive sores occur, which are sometimes attended with gangrene.

"There is often a copious flow of saliva; though, in some instances, this secretion, as well as that of the mucous follicles, is checked, and the mouth is clammy or dry. The sense of taste is usually more or less impaired, and speech and mastication are often difficult and painful. When the tongue is affected, its surface is, in general, first covered with a whitish fur, through which the red and swollen follicles may often be seen projecting. This fur sometimes breaks off, leaving the surface red, smooth, and glossy, with here and there prominent follicles; or the surface may be hard, dry, or gashed with painful fissures. When the gums are involved, they swell, and rise up between the teeth, around the necks of which they frequently ulcerate. In some cases this ulceration does not cease until it has extended into the sockets, and destroyed altogether the connections of the teeth, which become loosened and fall out, after which the gums will heal.

"Ordinary inflammation of the mouth is seldom so violent as to induce symptomatic fever. This form of inflammation is more frequently a complication of other diseases than an original affection. When of the latter character, it is generally caused by the direct action of irritant bodies, as by scalding drinks, acrid or corrosive substances taken into the mouth, or unhealthy secretions from decayed teeth. The sharp edge of a broken tooth sometimes gives rise to much inflammation, and even deep and obstinate ulcers,

especially of the tongue. Inflammation of the mouth may also result from the reaction which follows the long contact of very cold substances, such as ice, with the interior of the mouth. It sometimes proceeds from the propagation of inflammation from the fauces, and is a frequent consequence of gastric irritation produced by sour or acrid matter in the stomach. Drunkards seem peculiarly predisposed to it. Of the constitutional causes none are so frequent as the state of fever, which, whatever may be its peculiar character, is very apt to affect the mouth, and not unfrequently occasions inflammation."

Catarrhal Stomatitis.—Catarrhal stomatitis may be either acute or chronic, and a simple form is common to children under the age of one year; while this simple form gives rise in itself to no severe symptoms, yet it may be connected with other serious maladies, and hence is often overlooked. Acute catarrhal stomatitis first appears in the form of bright-red patches at the angles of the mouth and on the inside of the cheeks, which increase in size and sometimes unite, when the entire mucous surface of the mouth may become inflamed. While it is more intense in one part than in another, it may be confined to the tongue alone, or be universally diffused over the whole mucous membrane of the mouth. It is characterized by an increase of the heat and redness of the part affected, rapid proliferation and exfoliation of epithelial cells, and more or less dryness of the surface, as there is but little mucus secreted, with a high degree of sensibility, and pain when the lips or tongue are moved. The pain is of a smarting, burning character, the result of irritation on a denuded surface. Owing to the limited extent of connective tissue, the swelling of the inflamed mucous membrane is generally slight. In severe cases the gums become swollen and spongy, and bleed readily, and the entire surface of the mouth and tongue is covered with a white, viscid mucus; there is an increased flow of saliva, that is acrid and irritating, which may dribble from the corners of the mouth, causing a greater degree of congestion, which is apparent by the dark red color of the affected membrane. A fetid condition of the breath is not common to the acute form of catarrhal stomatitis unless shallow ulcers are present, which result from the rapid loss of the superficial cells and a failure in the development of others to supply their places. The engorgement of the vessels of the mucous membrane is followed by the exudation of white blood-corpuscles.

The intensity of this affection varies in different cases, sometimes existing in such a slight form as to cause little uneasiness, and

quietly disappearing, while at other times it may cause intense pain, and continue for weeks or months.

In a severe form it may extend to the œsophagus and stomach, or the larynx and trachea, and at last prove fatal, especially if there is present a decided state of cachexia, or a severe co-existing disease.

When it occurs during the period of dentition, to which it is common, it is often accompanied with fever, and sometimes, especially when long continued, by a profuse flow of saliva; occurring previous to dentition, it is seldom accompanied with fever.

When caused by dentition, the gum over the erupting tooth becomes inflamed, and the inflammation may extend over the entire buccal surface. But when due to the irritation of dentition, this form of stomatitis is generally more circumscribed than when it arises from a constitutional cause. It may also result from a mercurial course of treatment, exposure to cold, hot and stimulating food, or a diseased condition of the alimentary canal.

In adults catarrhal stomatitis may result from long-continued irritation of the mucous membrane of the mouth, or from injuries to the gums, such as may result from laceration in the extraction of teeth; also from the sharp edges of fractured teeth and roots, and constitutional derangement.

In very young children, among the early symptoms are restlessness and fretfulness, with refusal to take food, or, when attempting to do so, suddenly ceasing on account of the pain experienced.

Chronic catarrhal stomatitis is characterized by the structural changes which ensue on account of the stroma becoming affected. The mucous surface affected becomes indurated and thickened, the mucous glands are obstructed, and, as a result of their secretion being arrested, they become encysted and present a granular appearance on the surface of the membrane. The breath is more or less fetid, owing to the secretions of the mouth becoming vitiated, and the teeth are coated with sordes. The papillæ of the tongue become hypertrophied, but the substance beneath is less affected than in the acute form of this affection. The duration of the acute form is from three to six days as a general rule, while the chronic form is more persistent.

Simple stomatitis of children is readily relieved by means of emollient washes, such as solutions made from the slippery elm bark or the pith of sassafras, in cold water. When severe, a leech or two applied to the angle of the jaws will prove serviceable, and as a wash, the acetate of lead, in a solution composed of three grains to one fluidounce of water. A few doses of bromide of potassium may relieve the nervous excitement and fretfulness. One

part of borax to three of honey, or a drachm of borax to an ounce of glycerin and water, or a weak solution of alum, may prove useful local remedies.

The treatment of catarrhal stomatitis consists in first removing the cause of irritation, when such is present, and the use of alkaline washes, or, in more obstinate cases, a solution of either chloride of zinc or nitrate of silver, one grain to the ounce of water. Phenol sodique or phenate of soda will correct the fetor of the breath, when used in the form of spray. For the chronic form the following may be applied to the inflamed mucous surface, either in the form of a gargle or spray:—

℞. Acidi carbolici, ... ʒj.
Olei gaultheriæ, ... ʒij.
Glycerini, ... ʒij.
Olei menthæ piperitæ, ... ʒiij. M.

When the inflammation of the mouth is symptomatic of a diseased condition of the alimentary canal, the remedies adapted to such a condition are necessary.

Ulcerous Stomatitis, also known as "Noma," is another affection of the mouth which is common to childhood, the premonitory symptoms being the same as in simple stomatitis. The inflammation usually begins upon the gums and extends along the buccal surface. An examination of the mouth, however, at this stage of the disease, reveals one or more small, inflamed, and slightly elevated points or pimples, which, sometimes within a few hours, but more commonly after one or two days, present a softened and yellowish apex, and at length a small ulcer, superficial at first, but gradually becoming deeply excavated, with often an inflamed and elevated margin. The surfaces of these ulcers are covered with an ash-colored or a yellowish matter, in the majority of cases; but sometimes, instead of being thus covered, their surfaces are bare, and bleed readily.

Some of the ulcers may unite and form large, irregular ulcerations, while others remain isolated. The ulceration, when severe, gives rise to considerable swelling, especially around the ulcers, and the swollen part is soft, and not very tender on pressure. The soft, yielding nature of the swelling enables this form to be distinguished from gangrenous ulceration, as there is more induration in the latter affection. These ulcers result from acute phlegmonous inflammation, and may attack any part of the mucous membrane lining the mouth, but are most commonly found on the sides of the frænum, along the inferior margin and edges of the tongue, and inside the lips.

It is but seldom that they are found on the upper surface of the tongue; but when they do appear on this surface, they are generally superficial, and not deeply excavated.

When the ulcers in this form of stomatitis are fully formed, there is usually a profuse flow of saliva and a decrease of the febrile excitement. The bowels, which in the first stage of the disease are costive, now become loose, and often very much so during its continuance. A simple form of ulcerous stomatitis is characterized by but one or two small ulcers, which in a little time fill up with granulations and soon heal over. In a more severe form of this disease a considerable number of these ulcers exist, in some cases covering almost the whole of the mucous membrane of the gums, the inside of the cheeks, arch of the palate, sides and inferior surface of the tongue.

During the early stage of ulcerous stomatitis the mouth becomes hot and painful and the submaxillary glands swollen and tender. The breath becomes very offensive as soon as the ulceration is well established, and there is a tendency to keep the mouth open.

Another form of this disease is sometimes met with where but one or two ulcers exist, but which gradually extend over the mucous surface, at the same time increasing in depth, and with no appearance of healing. This form of the affection is attended with hectic fever, the exacerbations occurring night and morning, and rapidly wearing away the strength.

There is yet another form of ulcerous stomatitis occasionally met with, which consists of a softening of the mucous membrane of the palate in its centre, either on the median line or outside this line. The membrane appears to be softened into a kind of pulp, of a red or fawn color, which, on its removal, discloses an ulcer with perpendicular walls; the bone, however, forming its base is found to be perfectly healthy. It is the opinion of some that ulcerous stomatitis is contagious; that is, that it may be communicated by using the same spoon in eating, and also that it is endemic and epidemic. Ulcerous stomatitis is common to the period of dentition, especially when there is disorder of the digestive organs.

The causes of ulcerous stomatitis are uncleanliness, poor food, residence in damp, dirty places, mercury, a cachectic condition, enfeebled system, and contagion.

The treatment of ulcerous stomatitis consists in a change of residence and diet, cleanliness, the use of tonics, ferruginous or vegetable, such as the liquor ferri nitratis, with tincture of calumba, given in simple syrup, tincture of chloride of iron and sulphate of quinine, or cod-liver oil, and such local remedies as dilute chloride

of zinc, carbolic acid, nitrate of silver, muriatic acid, with an alternate wash of honey and borax, equal parts; or the chloride of lime applied dry to the ulcerated surface twice daily, and simple water used during the interval, and continued until a healthy appearance is apparent, when a weak solution of chloride of lime, one grain to forty-five of water, is employed. Chloride of lime one drachm, with honey one ounce, is also recommended. Chlorate of potassium often acts like a specific, employed internally and externally, the dose of which is two or three grains, dissolved in water with sugar, or in syrup.

The following formula may be employed:—

℞. Potass. chlorat,	ʒ ss to j.	
Mellis,	℥ ss.	
Aquæ,	℥ ij.	M.

One teaspoonful every two hours, and also applied as a lotion.

Dr. Condie recommends the following treatment where the ulcers are slow in healing: A solution of borax, gr. xv to the ounce of water, or a weak solution of the nitrate of silver, gr. j to the ounce of water, or sulphate of copper, gr. v to the ounce of water, or acidum nitricum dilutum applied by means of a camel's hair pencil to the whole of the ulcerated surface, which will improve the character of the ulceration and arrest its progress.

"Any apparent cause of irritation, such as a decayed tooth, should be removed." When there is great derangement of the alimentary canal accompanying ulcerous stomatitis, or this disease occurs during the course of other acute and chronic diseases, such as pneumonia, scarlet fever, smallpox, etc., the proper remedies adapted to the removal of these diseases are necessary.

Aphthous Stomatitis.—This form of stomatitis, sometimes called "follicular stomatitis," and also "canker sore mouth," although it is not confined to the seat of the follicles, is common to all ages, but is most frequent during childhood. The seat of the aphthæ is usually the inner surfaces of the lips and cheeks, the gums, the tongue, and sometimes the roof of the mouth. They commence with a vascular injection, which is followed in a few hours by a whitish exudation immediately below the epithelium and upon the corium, in the form of small, round or oval, isolated spots, the smallest being of the size of a pin's head, but the greater number of a diameter of one or two lines, causing slight vesicle-shaped elevations on the surface of the mucous membrane. The vesicles have a whitish appearance with an inflamed ring about their base; after their rupture an irregular gray surface is exposed, and the ulcers resulting are shallow and painful. After a few days the exu-

dation softens, and the points become denuded of epithelium, presenting superficial, painful ulcers, but without indurated edges. After an existence of one or two weeks the aphthæ disappear, leaving red spots, which, however, soon fade. Besides being very painful to the touch, and also to food and liquids, they are attended with an increased secretion of saliva.

Two or more of the ulcers may coalesce, forming one large ulcerated patch, to the edges of which vegetable fungi may adhere; in rare cases, it may become gangrenous, when the affection is usually complicated with gastro-intestinal disease. The constitutional symptoms are generally slight, except when there is a tendency to gangrene, which may cause a feeble pulse, pallid countenance, wasted body and limbs, and great prostration.

The causes of aphthous stomatitis may be bad hygienic conditions, uncleanliness, and privation, but it is usually owing to some derangement of the digestive organs, when it may also be accompanied with diarrhœa. It differs from ulcerous stomatitis in form of the aphthæ, and the inflammation being confined to the immediate vicinity of the ulcers, and not extending over the mouth.

The treatment of aphthæ consists in the application of demulcent drinks, such as the mucilage of gum acacia, flaxseed, or marshmallow. Mel-boracis, honey of borax, is an efficient application applied with a camel's-hair pencil, and a small quantity of some opiate to relieve the tenderness of the ulcers and the restlessness. When the ulcers, besides being painful, are not disposed to heal, they may be touched with nitrate of silver or with hydrochloric acid in honey of roses, or nitric acid applied on the sharpened end of a stick of orange wood. The application of chlorate of potassium is also effective in some cases. The constitutional treatment consists in the administration of citrate of magnesia or rhubarb to correct the intestinal trouble, and tonics of sulphate of quinine or other vegetable bitters, or of the tincture of the chloride of iron, to keep up the strength. When there is a great number of the ulcers, with considerable fever, and symptoms of cerebral congestion or of convulsions, the administration of laxatives and the bromides, with a warm foot-bath, will prove beneficial.

Thrush.—This affection, also known as "sprue" and "muguet," is characterized by a form of inflammation which consists of points and patches of a curd-like appearance on the surface of the mucous membrane of the mouth, its common seat, as the fauces, pharynx, and œsophagus are only occasionally affected.

Thrush commences as simple inflammation of the mucous surface, which is followed by the appearance of minute semi-trans-

parent points or granules, which soon become white and opaque. While some remain as points, others extend, and by coalescing form patches, the surfaces of which are not uniform, but unequally elevated.

The central part of the points and patches project but little above the surrounding epithelial surface, being not more than a line in height. They resemble in color and consistence portions of curdled milk, for which they may be mistaken. Being very easily detached, they are rapidly reproduced, and their white color may change to a yellow hue.

Composed of epithelial cells and a parasitic vegetable growth, of the oïdium albicans variety, each point consists of roots, branches, and sporules, the roots being transparent, and penetrating the epithelial layer, and sometimes even as far as the basement membrane. The branches divide and subdivide, and consist of elongated cells with one or two nuclei. Around the branches are numerous sporules. Thrush, in its mildest form, appears in points or small patches; and if the patches are of large extent, which, however, rarely occurs, the affection is attended by a state of great prostration and danger from some concomitant disease. Often it occurs as the sequel of pneumonia or gastro-intestinal inflammation, in the latter case being caused by neglect, improper food, or a deprivation of the maternal milk. In the mildest cases, the symptoms are similar to those of simple stomatitis. When the inflammation is more extensive, and especially if the fauces and œsophagus are involved, the inflamed surface becomes very hot, red, and painful, and there is fretfulness and fever. In the severest forms, the surface becomes dry and parched, the inflammation more extensive, and there is thirst, loss of appetite, vomiting, and frequently diarrhœa, with an anxious, pallid countenance, rapid emaciation, and extreme prostration.

When thrush is complicated with aphthæ, small, white, flocculent patches appear on the surface of the mucous membrane, which increase in size and finally coalesce. In such patches some form of vegetable parasite exists, more commonly that known as oïdium albicans.

The causes of thrush are bad hygienic conditions, constitutional feebleness, indigestion, and improper food. It is common among emaciated children in crowded institutions, or where there is exposure to dampness. Foul nursing-bottles are also a common cause of this affection. It appears to be more prevalent during the summer months, and to occur more frequently under the age of three months.

Even children of eighteen months, suffering from debilitating diseases, are subject to it. The stools are greenish and acrid, giving rise to excoriations of the parts with which they come in contact. When this disease occurs in adults, it is attended with an increased flow of saliva and a dry, hot state of the mouth, rendering deglutition painful.

The treatment of thrush should commence with an improvement in the diet and locality, if these are at fault, and the administration of an alkali to correct the acidity of the secretions which is usually present. Saccharate of lime added to the milk is very beneficial. The following combination is recommended by Dr. Sudduth:—

℞.	Infusi rhei,	℥ iij.	
	Potassi bicarb.,	ʒ j.	
	Tincturæ cinnamomi,	ʒ ij.	
	Syrupi simp.,	ʒ vj.	M.

Dose. A teaspoonful every three hours for an adult.

Quinine in one-grain doses every three hours will prove beneficial for infants. The quinine may be combined with tincture of the chloride of iron to produce a tonic effect, one drachm of the quinine with one ounce of the iron, in doses of fifteen drops every three hours. Dr. Trousseau recommends the following alterative tonic, which is very effective:—

℞.	Hydrarg. chloridi corrosivi,	gr. j–ij.	
	Liq. arsenici chloridi,	f ℥ j.	
	Tinct. ferri chloridi,		
	Acid. hydrochlorici dil., aa	f ʒ iv.	
	Syrupi,	f ℥ iij.	
	Aquam,	ad f ℥ vj.	M.

Dose. One dessertspoonful in a wineglassful of water after each meal.

The local treatment consists in the application of borax with honey—mel-boracis—or borax with powdered sugar, or dissolved in water. Some object to the use of sugar, as it promotes the growth of the parasite. Prof. J. L. Miller recommends the following:—

℞.	Sodii borat.,	ʒ j.	
	Glycerinæ,	ʒ ij.	
	Aquæ,	ʒ vj.	M.

Sig.—To be applied with a camel's hair pencil four or five times a day.

If such an application fails, which is rarely the case, then recourse must be had to a solution of nitrate of silver or sulphate of zinc.

℞.	Zinci sulph.,	gr. ij–iv.	
	Aquæ rosæ,	℥ ij.	M.

When thrush is complicated with other diseases, the proper treatment for such diseases may render its treatment easy and effectual.

Gangrene of the Mouth.—This disease, characterized by such names as "Cancrum Oris," "Gangrænopsis," "Canker of the Mouth," "Water Canker," is common to children of debilitated constitutions and a decided lymphatic temperament, the result of scanty nourishment, improper clothing, and damp, unhealthy places of abode, or where many children are crowded together in charitable institutions. There are several forms of this affection, the most common, perhaps, being preceded by inflammation of the gums, with such premonitory symptoms as great languor and listlessness, indisposition to any exercise, irritable temper, loss of sleep and appetite, and increase of thirst. The countenance becomes pale and dejected, and a peculiar puckering of the cheeks is observed about the corners of the mouth. Emaciation and night-sweats are not uncommon.

These premonitory symptoms may continue for several days, or even weeks, when an acute pain is felt in the mouth and gums, with a sense of heat and itching about their margins, the free edges of which become congested and thickened, spongy, and of a dark red or purple hue, bleeding readily.

The flow of saliva increases greatly, and is frequently mixed with blood. From about the necks of the teeth a muco-purulent matter is discharged, which after a time becomes thin, watery, and acrid, rendering the breath very offensive. In the majority of cases this disease is confined to one side of the mouth and to the lower jaw, and if allowed to progress, the gums separate from the necks of the teeth and alveolar processes, and become ragged, flabby, and livid; the teeth on the affected side loosen, and at length drop out, and at this stage there is an increase of the febrile symptoms and night-sweats. In such a state the gums may continue for weeks or even months, but usually after a few days a number of ash-colored vesicles make their appearance, which rapidly increase in size and become confluent, the divided gum presenting a gangrenous appearance. The dead portions separate, a gangrenous ulcer follows, and soon the entire part is destroyed and the inferior maxillary bone exposed. The ulceration is more common to the labial surface than to the lingual, and commences in the front part of the mouth, extending to posterior parts. The ulcers, before becoming gangrenous, are covered with a yellow or gray secretion, which, on being removed, exposes many small, red papillæ, which correspond to imperfect granulations. After a time the gangrenous ulceration extends to the mucous membrane of the cheek and lips, causing pain and difficulty in attempting to open the mouth, which is sometimes impossible.

In a short time the whole of the mouth becomes affected, and

death usually occurs at about the eighth or, at the furthest, upon the fourteenth day from the commencement of the gangrene.

Mr. Tomes remarks that although the disease is usually confined to children during the shedding of the temporary teeth, yet adults are not wholly exempt from its attacks.

There is another form of this disease which differs considerably from that just described, from the fact that it is not preceded by inflammation of the gums, but commences in the cheek, usually at the angle of the lips, and comes on abruptly, without the premonitory symptoms characteristic of the first form described.

There is first seen a hard, indolent tumor, about the size of an almond, in some part of the lips or cheek, which is deeply seated, the skin covering it being somewhat redder than natural. This tumor gradually increases in size for a few days, when the mucous membrane covering it presents a gangrenous appearance, with an offensive odor. Before this occurs, however, the external redness of the skin covering the tumor becomes pale, then livid, then of a grayish hue, surrounded by a red circle, which spreads rapidly and in a few hours changes to a black color.

The gums nearest to this tumor then become gangrenous, and the teeth loosen and at length fall out. Death usually occurs before the death of the bone of the jaw. There is also a superficial form of gangrene sometimes met with in the form of spots of a dark-brown color surrounded by a red margin, which vary in size, and have for their seat the corners of the lips and inner surfaces of the cheeks. These spots may first appear in the form of slightly reddened patches, but in this mild form are always superficial, confined to the mucous membrane alone, the sloughs separating with little loss of substance, soon to be followed by healthy granulations and cicatrization.

Gangrene of the mouth may occur at any period between the first and tenth year of age, but is more common between the second and fourth years ; and the children subject to it are those of a lymphatic temperament, delicate constitution, soft, flaccid muscles, pale skin, and whose digestive organs are deranged. It usually occurs in those whose systems are much reduced or cachectic, and is more common to children crowded together in asylums and those deprived of pure air and proper nourishment, or enfeebled by disease. It sometimes follows the eruptive fevers, and such diseases as pneumonia, scrofula, whooping-cough, typhus fever, ague, etc.

In the treatment of gangrene of the mouth no little depends upon the time this is instituted. Before the gangrene makes its appearance much may be done in the way of preventive treatment, in

order to remove the existing predisposition. A dry, pure air, cleanliness, and a nourishing diet adapted to the condition of the digestive organs are very essential. The preparations of iron and bitter vegetable tonics are required.

The administration of the sulphate of quinine, and the local application of a strong decoction of white oak bark, is thought, by Dr. Condie, to be beneficial in preventing gangrene of the mouth in cases in which there is every reason to anticipate its speedy occurrence. For local treatment solution of sulphate of zinc (one drachm to the ounce of water), to which is added honey and tincture of myrrh, two drachms of each, will prove serviceable. Nitrate of silver, either in the solid form or in solution, applied to the affected part, has been successfully employed in a large number of cases.

When the disease is established, the first indication in the local treatment is to arrest the progress of the gangrene and hasten the detachment of the slough, and for such purposes highly stimulating or escharotic agents are required. The affected parts should be well cleansed, and then sprayed with carbolized water and strong acetic, sulphuric, nitric, or hydrochloric acids, nitrate of silver, acid nitrate of mercury, or chloride of antimony, applied, by means of a brush, on and about the slough, to be at once followed by the application of dry chloride of lime, when the mouth is to be thoroughly washed out with water, by means of a syringe. By such applications to the edges of the ulcers, the diseased tissue is destroyed and healthy granulations promoted.

After the separation of the slough the escharotic is to be discontinued and the chloride of lime alone employed. Some, however, prefer milder remedies than the strong acids, such as the nitrate of silver, if the slough is small in extent; if larger, muriated tincture of iron is applied, undiluted, and after the progress of the gangrene is arrested the use of astringent stimulants, such as tincture of myrrh or the French aromatic wine.

Dr. Coates found sulphate of copper, according to the following formula, to be successful:—

℞. Cupri sulph., ...	ʒij.	
Pulv. cinchonæ, ...	℥ss.	
Aquæ, ...	℥iv.	M.

To be applied twice a day to the entire ulcerations and excoriations

In milder cases a solution of sulphate of zinc, ʒj to an ounce of water, by itself or combined with tincture of myrrh, is found to be useful. If the milder agents, after two or three days' use, do not prevent the gangrene from spreading, strong hydrochloric acid,

applied by a camel's-hair pencil, may prove efficacious, and its use immediately followed by lime-water made turbid by lime. To correct the fetor, chlorine or carbolic acid, properly diluted, may be employed alternately with the sulphate of copper, or Labarraque's solution of chlorinated soda, one part to eight or ten parts of water. The tincture of myrrh, with tonics and a nutritious diet, should complete the treatment.

Dr. Condie recommends the administration of sulphate of quinine during the time the local remedies are being applied, as follows:—

℞. Quiniæ sulphat.,	gr. x.	
Acid. sulph. dil.,	♏x.	
Sacch. alb.,	ʒiv.	
Aq. cinnamom.,	℥iv.	M.

Dose: A teaspoonful every three hours.

The free internal use of the chlorate of potassa, one to three scruples in twelve hours, according to the age of the child, has been employed with advantage.

For the diarrhœa accompanying the disease, and especially when it is profuse, Dr. Condie recommends acetate of lead, as follows:—

℞. Acetat. plumbi,	gr. xvj.	
Cretæ præp.,	℈iiss.	
Ipecacuanhæ,	gr. iv.	
Opii pulv.,	gr. ij.	M.

To be divided in xvj portions; one to be given every three or four hours.

Syphilitic Ulceration of the Mouth.—Syphilitic ulcers are the secondary results of constitutional syphilis, and are usually found on the tongue, the lips, or the tonsils. Although the syphilitic ulcer is usually superficial, little irritating, and attended with the discharge of a small amount of pus, it is occasionally phagedenic in character. Such ulcers, as a result of constitutional syphilis, may be incited by abrasions and injuries caused by fractured and carious teeth upon the sides of the tongue, and they may appear on the lip as the result of kissing. These ulcers also appear upon the tonsils and pharynx. These syphilitic ulcers may be distinguished from more malignant ones by their improvement under specific medication and the other indications of constitutional syphilis generally present and recognizable. The glands of the neck are often found enlarged when syphilitic ulcers exist in the mouth or on the lips. Local and constitutional treatment is required in the majority of cases. The local treatment consists in the application of a solution of chromic acid—ten grains to the ounce of water,—by means of a camel's-hair brush, three times a day. When such applications fail, the administration of mercury

is necessary; and in all cases a total abstinence from alcoholic drinks and tobacco is required.

Mercurial Stomatitis.—The employment of mercury as a medicinal agent causes increased watery evacuations, increased flow of bile and saliva, and, as a consequence, increases the flow of blood to the secreting part. But when administered in excess other effects follow. It is capable of producing inflammation, especially the acute, phlegmonous, adhesive variety. The effects of its use depend upon the quantity administered and the susceptibility of the patient to its action. When carried to excess, the mucous membrane of the mouth becomes tender, red, and swollen, the glands beneath the jaw become painful, and at length ulceration occurs, which spreads from the gums—where the effects of the drug are first observed—to fauces and throat, and, in extreme cases, the parts affected may perish.

Prof. Wood describes this disease as follows: "Among the first indications of the action of mercury are often a metallic taste in the mouth, like that of brass or copper, and some increase of saliva. At the same time a close examination will detect a slight redness and swelling of the gums, particularly about the necks of the lower incisors, while somewhat below their edge a broad, white line may be observed, depending on opacity of the epithelium.

"The patient soon begins to feel some uneasiness, complaining of soreness when the gums are pressed, and of pain when the teeth are forcibly closed together. There is also a sense of stiffness about the jaws when the mouth is opened, and they feel as if projecting above their proper level. The flow of saliva increases, the inflammation extends, the gums and palate become obviously swollen, and the tongue covers itself with a yellowish-white or brownish fur, and is often so much enlarged as to exhibit the impression of the teeth upon being projected from the mouth. The throat frequently becomes sore, and the cheeks and salivary and absorbent glands swollen and painful. There is often severe toothache or pain in the jaws. A whitish exudation along the edges of the gums is very common.

"The breath, which sometimes from the beginning, and sometimes even before the appearance of any one of the symptoms mentioned, has a peculiar, disagreeable odor, now becomes extremely offensive, and in bad cases almost intolerable. Ulceration often occurs, especially about the necks of the teeth, which are consequently loosened, and in the cheeks, lips, and fauces. The ulcers often have their origin in a vesicular eruption. The whole mouth with its appendages is sometimes so swollen that it can scarcely be

opened, and the tongue so much enlarged as to project beyond the lips.

"The patient is now nearly or quite unable to articulate or to masticate his food, and sometimes can scarcely swallow. Hemorrhage is not an unfrequent attendant upon the bad cases, and is sometimes so profuse as to be alarming. Sloughing also takes place, and portions of the jawbone are occasionally laid bare. There is always in the severe cases more or less fever, which is partly symptomatic of the local affection and partly the direct effect of the mercury. Death, from the exhausting influence of the irritation, want of nourishment, and hemorrhage, has occurred in numerous instances, but the patient usually recovers from the worst forms of the affection, though sometimes with a deformed mouth.

"The tongue and cheeks have occasionally adhered at points where their ulcerated surfaces were in contact, and a surgical operation has been necessary to remove the evil."

For the treatment of mercurial stomatitis, see "Treatment of Mercurial Inflammation of the Gums."

Scurvy-Scorbutus is a disease characterized by spongy gums, offensive breath, livid spots on the skin, great general debility, and a pale, bloated countenance.

"Scurvy," remarks Prof. Wood, "is generally very gradual in its approach, so that it is scarcely possible to say, in any particular case, what was its precise time of attack. Attention is commonly first attracted by an unhealthy paleness of complexion, a feeling, on the part of the patient, of languor and despondency, with an indisposition to bodily action, and unusual fatigue after exercise; a sensation of weariness and aching in the limbs, as from over-exertion, though the patient may have been at rest; and some swelling, redness, and tenderness of the gums, with a tendency to bleed from slight causes. With the advance of the disease, the face becomes paler, and assumes a somewhat sallow or dusky hue, and often a degree of puffiness; the lips and tongue become pallid and contrast strikingly with the gums, which are purple or livid, especially at their edges, rise up between and around the teeth, are soft and spongy, and bleed from the slightest touch; the breath is offensive; purplish spots or blotches appear upon various parts of the surface, beginning usually upon the lower extremities, and afterward extending to the trunk, arms, and neck, though seldom affecting the face; hemorrhage frequently occurs, most commonly from the nose, gums, and mouth, but sometimes from the stomach, bowels, and urinary passages; the feet become œdematous and the legs swollen and painful; the general debility increases, and muscular exertion

is apt to be attended with palpitation of the heart, panting, vertigo, dizziness, and a feeling of faintness. The petechial spots are evidently owing to the extravasation of blood within the cutaneous tissue. Occasionally portions of the surface look as if bruised without having suffered any violence; and blows which, under ordinary circumstances, would produce no effect, now give rise to extensive ecchymosis. Should the disease continue, all the symptoms become aggravated; the complexion assumes often, with its paleness, a livid or leaden hue; the gums swell greatly, and put forth a blackish, fungous growth, so as sometimes to conceal the teeth; blood continually oozes from them; sloughing occasionally takes place, laying bare the necks of the teeth, and extending, in very bad cases, even to the cheek.

"The teeth become loose and sometimes fall out; the patient is unable to chew solid food, in consequence of the state of his gums. The breath becomes intolerably offensive; hard and painful tumefactions occur in the calves of the leg, among the muscles of the thigh, upon the tibiæ and lower jaw, and in the hand, with stiffness and contraction of the joints, especially the knee, and severe pain in the extremities upon every attempt at movement; and the debility, before so prominent a feature in the case, now becomes excessive, so that the least exertion is dangerous, and the patient sometimes dies suddenly upon rising from bed or upon being conveyed, without great caution, from one place to another. Wounds, even slight scratches, degenerate into unhealthy ulcers; old cicatrices break out afresh, and existing ulcers assume a new and much worse aspect. The bones are said to be softened, united fractures are again opened, and in the young the epiphyses separate sometimes from the shaft.

"Throughout the complaint the tongue is usually clean and moist; and the appetite and digestion remain unimpaired almost to the last, unless the disease, as sometimes happens, should be complicated with fever. Indeed, there is often a craving for food, especially for fresh vegetables and fruits; occasionally, however, there is vomiting, with epigastric distress and other evidences of stomachic disorder. The bowels are mostly costive, and in some cases obstinately so, but diarrhœa not unfrequently intervenes, with black or bloody and offensive evacuations. The pulse is generally small, feeble, and slow; but cases occur in which it becomes very frequent, and the surface of the skin febrile, probably from the sympathy of the system with various local irritative congestions.

"Great emaciation usually attends the disease when severe or lasting, but not invariably. Little cerebral disturbance is ordinarily

observable, and the patient often retains full possession of his senses and intellect to the last."

In regard to the cause of scurvy, it is the general belief that it results from the absence of fresh vegetables and fruits. Prof. Hamilton says: "In regard to the pathology of scurvy, the belief prevails that it is due essentially to the absence of certain staminal principles from the blood, and especially potash; as all, or nearly all, the remedies which have been employed sucessfully in the prevention or cure of scurvy contain potash, such as potatoes, cabbage, celery, lettuce, lime, lemon, and orange juice." As regards the treatment, both local and constitutional are required. The local treatment, being the same as is recommended for "mercurial stomatitis," need not be repeated. The constitutional treatment consists in the administration of the vegetable acids, such as lemonade, for example. Turner's antidote, composed of potassæ nitratis ʒij, and acidi acetici, ℥viij, in tablespoonful doses, three times a day, is a favorite remedy. In connection with this, Dr. Garretson recommends saturating a sheet with water moderately warm and moderately salt, which is thrown around the body each morning immediately on rising, and rubbed against the flesh until a ruddy glow is excited.

CHAPTER IV.

DISEASES OF THE GUMS.

LITTLE can be ascertained concerning the innate constitution from an inspection of the gums. Subject to the laws of the general economy, their appearance varies with the state of the general health and the condition and arrangement of the teeth. Although the proximate cause of disease in them may be specified as local irritation—produced by depositions of tartar upon the teeth, or decayed, dead, loose or irregularly arranged teeth, or by a vitiated state of the fluids of the mouth, resulting from general organic derangement, or any or all of the first-mentioned causes—their susceptibility to morbid impressions is influenced to a considerable extent by the constitutional health; and the state of this determines, too, the character of the morbid effects produced upon them by local irritants. For example, the deposition of a small quantity of tartar upon the teeth, or a dead or loose tooth, would not, in a healthy person of a good constitution, give rise to anything more than slight increased vascular action in the margin of the gums in contact with it; while in a scorbutic subject it

would cause them to assume a dark purple appearance for a considerable distance around, to become swollen and flabby, to separate and retire from the necks of the teeth, or to grow down upon their crowns, to ulcerate and bleed from the slightest injury, and to exhale a fetid odor. In proportion as this disposition of body exists, their liability to be thus affected is increased; and it is only among constitutions of this kind that that peculiar preternatural morbid growth takes place by which the whole of the crowns of the teeth sometimes become almost entirely imbedded in their substance.

But, notwithstanding the dependence of the condition of the gums upon the state of the constitutional health, they are occasionally affected with sponginess and inflammation in the best temperaments, and in individuals of uninterrupted good health. The wrong position of a tooth, by causing continued tension of the gums investing its alveolus, sooner or later gives rise to chronic inflammation in them and the alveolo-dental periosteum, and gradual wasting of their substance about the mal-placed organ. The causes of toothache, too, often produce the same effects; the accumulation of salivary calculus upon teeth, however small the quantity, is likewise prejudicial.

All of these may occur independently of the state of the general health. A bad arrangement of the best constituted teeth, and toothache may be produced by a multitude of accidental causes disconnected with the functional operations of other parts of the body.

While, therefore, the appearance and physical condition of this peculiar and highly vascular structure are influenced in a great degree by habit of body, they are not diagnostics that always, and with unerring certainty, indicate the pathological state of the general system. It can, however, in by far the larger number of cases, where the gums are in an unhealthy condition, be readily ascertained whether the disease is altogether the result of local irritation, or whether it is favored by constitutional tendencies.

In childhood, or during adolescence, when the formative forces of the body are all in active operation, and the nervous susceptibilities of every part of the organism highly acute, the sympathy between the gums and other parts of the system, and particularly the stomach, is, perhaps, greater than at any other period of life. The general health, too, at this time is more fluctuating, and with all the changes this undergoes, the appearances of the gums vary. Moreover, there are operations carried on beneath and within their substance which are almost constantly altering their appearance and physical condition; and which, being additionally influenced

by various states of health and habits of body, it may readily be conceived that those met with in one case might be looked for in vain in another.

Having arrived at that age when all the organs of the body are in full vigor of maturity, and not under the debilitating influences to which they are subject during the earlier periods of life, the gums participate in the happy change, and, as a consequence, present less variety in their characteristics. The general irritability of the system is not now so great, the gums are less susceptible to the action of irritating agents, and, as a consequence, less frequently affected with disease; but as age advances, and the vital energies begin to diminish, the latent tendencies of the body are reawakened, and they are again easily excited to morbid action, and exhibit a darker color and thicker structure, with a tendency to bleed; and such conditions in an exaggerated form appear in dyspeptic persons and those subject to glandular struma.

In the most perfect constitutions, and during adolescence, they present the following appearances: they have a pale rose-red color, a firm consistence, a slightly uneven surface; their margins form along the outer surfaces of the dental circle beautiful and regular festoons, with a very thin edge around the teeth and firmly attached near their necks, with the interstices so filled up that but little food can collect between the teeth, and the mucous membrane here, as well as in other parts of the mouth, has a fresh, lively, roseate hue.

The time for the eruption of a deciduous tooth is announced some weeks before it takes place by increased redness and slight tumefaction of the edges and apices of the gums surrounding it. The eruption of a tooth, whether of the first or second set, is also preceded by similar phenomena in the gums through which it is forcing its way, and these will be more marked as the condition of the system is unhealthy, or as the habit of the body is bad.

If the health of the subject continues good, and the teeth are well arranged, and the necessary attention to their cleanliness be strictly observed, the characteristics just enumerated will be preserved through life, except there will be a slight diminution of color in them after the age of puberty until that of the climacteric period of life, when they will again assume a somewhat redder appearance. But if the health of the subject becomes impaired, or the teeth be not regularly arranged, or wear off, or are not kept free from all lodgment of extraneous matter, their edges, and particularly their apices, will inflame, swell, and become more than ordinarily sensitive.

The gradual wasting or destruction of the margins of the gums around the necks of the teeth, which sometimes take place in the best

constitutions, and is supposed by some to be the result of general atrophy, is ascribable, we have no doubt, to some one or other of these causes, favored, perhaps, by a diminution of vitality in the teeth, whereby they are rendered more obnoxious to the more sensitive and vascular parts within which their roots are situated. That these are the causes of the affection (for it is evidently the result of diseased action in the gums) is rendered more than probable by the fact that it rarely occurs with those who, from early childhood, have been in the regular and constant habit of thoroughly cleansing their teeth from four to five times a day.

Although possessed of a good constitution, a person may, by intemperance, debauchery, or long privation of the necessary comforts of life, or by protracted febrile or other severe kinds of disease, have his assimilative and all the other organs of the body so enervated as to render every part of the system highly susceptible to morbid impressions of every sort; but still this general functional derangement rarely predisposes the structure now under consideration to any of the more malignant forms of disease occasionally known to attack it in subjects of less favorable constitutions. The margins of the gums may inflame, become turgid, ulcerate, and recede from the necks of the teeth, and the whole of their substance be involved in an unhealthy condition; but they will seldom be attacked with scirrhous or fungous tumors, or bad-conditioned ulcers, or affected with preternatural morbid growths; and in the treatment of their diseases we can always form a more favorable prognosis in persons of this description than those coming into the world with some specific morbid tendency.

But the occurrence of severe constitutional disease, even in these subjects, is followed by increased irritability of the gums, so that the slightest cause of local irritation gives rise to an afflux of blood to, and stasis of this fluid in, their capillaries.

The teeth of persons thus happily constituted are endowed with characteristics such as have been represented as belonging to those of the best quality. They are of a medium size, both in length and volume, white, compact in their structure, generally well arranged, and seldom affected with caries.

Another constitution is observed, in which the gums, though partaking somewhat of the characteristics just described, differ from them in some particulars. Their color is of a deeper vermilion; their edges rather thicker, their structure less firm, and their surface not so rough, but more humid. The mucous membrane has a more lively and animated appearance. They are more sensitive and more susceptible to the action of local irritants, with morbid tendencies

more increased by general organic derangement, than when possessed of the appearances first mentioned.

When in a morbid condition the disease, though easily cured by proper treatment, is, nevertheless, more obstinate, and when favored by constitutional derangement assumes a still more aggravated form. Their predisposition to disease is so much increased by long continued disturbance of the general system, and especially during youth, and by febrile or inflammatory affections, that not only their margins, but their whole substance, sometimes become involved in inflammation and sponginess, followed by ulceration of their edges and recession from the necks of the teeth, which, in consequence, loosen and often drop out. But gums of this kind, like those first described, seldom grow down upon the crowns of the teeth. Neither are they very liable to be attacked with scirrhous or fungous tumors, or any form of disease resulting in sanious or other malignant conditioned ulcers. Indeed, with diseases of this kind they are not, perhaps, ever affected, except in those cases where every part of the body has become exceedingly depraved by intemperance, debauchery, or some other cause.

The teeth of those whose gums are of this description, if well arranged and kept constantly clean, and if the secretions of the mouth be not vitiated by general disease, will, in most cases, remain healthy through life.

It is only among sanguineous persons that this description of gums is met with, and the teeth of subjects of this kind are generally of excellent quality, and though more liable to be attacked by caries than those first noticed, they are seldom affected with it.

In sanguineo-serous and strumous subjects the gums are pale, and, though their margins are thin and well festooned, often exude, after the twenty-fifth and thirtieth year, a small quantity of muco-purulent matter, which, on pressure, oozes from between them and the necks of the teeth. Their texture is usually firm, and they are not very liable to become turgid. They often remain in this condition to a late period of life without undergoing any very perceptible change. Their connection with the necks of the teeth and alveolar processes appears weak, but they rarely separate from them.

In individuals having such constitutions, dyspepsia, chronic hepatitis, and diseases in which the *primæ viæ* generally are more or less involved are not unfrequent, and are indicated by increased irritability, and sometimes a pale, yellowish appearance of the gums. In jaundice, the yellowish serosity of the blood is very apparent in the capillaries of this structure.

These constitutions are more common in females than males, in the rich than the poor, and in persons of sedentary habits than in those who use invigorating exercise. If at any time during life the health is ameliorated, the gums assume a fresher and redder appearance, and the exudation of muco-purulent matter from between them and the necks of the teeth ceases.

In mucous dispositions, the gums have a smooth, shining appearance, and are rather more highly colored than the preceding. Their margins, also, are thicker, more flabby, and not so deeply festooned; they are more irritable, and, consequently, more susceptible to morbid impressions.

If with this disposition there be combined a scorbutic or scrofulous tendency, the gums during early childhood, in subjects which, from scanty and unwholesome diet, have become greatly debilitated, are liable, besides the ordinary forms of disease, to another—characterized by their separation from, and exfoliation of, the alveolar processes, accompanied by a constant discharge of sanies. This form of disease, however, though peculiar to childhood and wholly confined to the indigent, is by no means common.

These constitutions are rarely met with, except among persons who live in cellars and damp and closely confined rooms in large cities, and in low, damp, and sickly districts of country. The mucous membrane in subjects of this kind is exceedingly irritable, and secretes a large quantity of mucus.

Persons even thus unhappily constituted do, sometimes, by change of residence and judicious regimen, acquire tolerably good constitutions. Little advantage, however, is derived from these, unless they are had recourse to before the twenty-fifth or thirtieth year of age, though they may prove beneficial at a much later period.

The gums in scorbutic persons have a reddish-brown color; their margins are imperfectly festooned and thick; their structure rather disposed to become turgid, and ever ready, on the presence of the slightest cause of local irritation, to take on a morbid action. When thus excited, the blood accumulates in their vessels, where, from its highly carbonized state, it gives to the gums a dark purple or brown appearance; they swell and become spongy and flabby, and bleed from the slightest touch. To these symptoms supervene the exhalation of a fetid odor, the destruction of the bond of union between them and the necks of the teeth, suppuration and recession of their margins from the same gradual wasting of the alveolar cavities, loosening, and, not unfrequently, the loss of several or the whole of the teeth. These are the most common results, but sometimes they take on other and more aggravated forms of diseased

action: preternatural, prurient growths of their substance, fungous aud scirrhous tumors, ichorous and other malignant and ill-conditioned ulcers, etc.

The occurrence of alveolar abscesses in dispositions of this kind is often followed by necrosis and exfoliation of portions of the maxillary bone, and the effects which result to the gums are always more pernicious than in habits less depraved.

The development of the morbid changes which take place in this structure, even in subjects of this kind, while the character of the disease is influenced, if not determined, by a specific constitutional tendency, is, nevertheless, referable to local irritation as the immediate or proximate cause, and were this the proper place, we could cite numerous cases tending to establish the truth of this opinion.

In scrofulous habits, the gums have a pale bluish appearance, and when subject to local irritation they become flabby, exhale a nauseating odor, detach themselves from the necks of the teeth, and their apices grow down between these organs. The blood circulates in them languidly, and debility seems to pervade their whole substance. They are exceedingly irritable, and not unfrequently take on aggravated forms of disease, and as often happens to this, as well as to the preceding habit, there are combined tendencies which favor the production of ill-conditioned tumors and ulcers.

The indications furnished by the gums during the existence of a mercurial diathesis of the system are morbid sensibility, increased vascular and glandular action, foulness, bleeding from the most trifling injuries, pale bluish appearance of their substances, turgidity of their apices, and sloughing. The effects, however, resulting to these parts from the employment of mercury differ in different individuals, according to the general constitutional susceptibility, the quantity taken into the system, and the length of time its use has been continued. In persons of very irritable habits a single dose will sometimes produce ptyalism, and so increase the susceptibility of the gums that the secretions of the mouth, in their altered state, will at once rouse up a morbid action in them.

The effects of a mercurial diathesis upon these parts is not unfrequently so great as to result in the loss of the whole of the teeth. But with these effects both the dental and medical practitioner are too familiar to require any further description.

Finally, we would observe, that the indications of the several characteristics to which we have now briefly alluded may not be correct in every particular, and there are others which we have not mentioned; yet we think they will commonly be found true. As a

general rule, persons of a full habit, though possessed of mixed temperaments and in the enjoyment of what is usually called good health, have gums well colored, with rather thick margins, and very susceptible to local irritation. With this description of individuals, inflammation, turgidity, and suppuration of the gums are very common. To prevent these effects, constant attention to the cleanliness of the teeth is indispensable.

Prof. Schill says, the "gum is pale in chlorosis anæmia; of a purple red color before an active hemorrhoidal discharge and in cases of dysmenorrhœa; of a dark red color, spongy, and bleeding readily in scurvy and diabetes mellitus and after the use of mercury. Spongy growths indicate caries of the subjacent bone."

Regular periodical bleedings of the gums in dysmenorrhœa, and particularly in scorbutic and mucous subjects, are not unfrequent, nor in any case where they are in a turgid condition.

Spongy growths of the gums in scorbutic and scrofulous persons often result from irritation produced by decayed teeth, and are not, therefore, always to be regarded as an indication of caries of the subjacent bone.

Dr. T. Thompson, of London, says that the reflected margin of the gums of a large majority of phthisical patients is deeper in color than the other portions, usually presenting a vermilion tint.

Mr. George Waite says: "A change of residence to a damp climate will often rouse up in the gums a great degree of vascularity. In the damp places of England and Ireland the appearances which the gums present are of a turgid and vascular nature. In the damp countries of France, these conditions of the gums run a much greater length, from the circumstance of the difference in the constitutions of the two nations. In the damps of Germany and Switzerland persons also lose their teeth early in life; the climate engenders malaria and low fevers, enfeebles the power of digestion, and brings on rheumatic affections, with languor and general constitutional debility."

Of the correctness of Mr. Waite's observations there can be no question, and they go to establish what has been said in regard to the predisposing cause of disease in the gums; namely, that the enervation of the vital powers of the body, from whatever cause produced, increases their susceptibility to morbid impressions.

INFLAMMATION OF THE GUMS.

The gums and alveolar processes, from apparently the same cause, frequently assume various morbid conditions. An unhealthy action in one is almost certain to be followed by disease in the other. The most common form of disease to which these parts are

subject is usually, though very improperly, denominated scurvy, from its supposed resemblance to *scorbutus*, a disease to which, however, it bears no resemblance. Instead, therefore, of continuing the use of this term, we propose to treat the disease under the name of *chronic inflammation and tumefaction of the gums, attended by recession of their margins from the necks of the teeth*, which seems to express more clearly the condition of the parts and the nature of the disease. The gums sometimes, though less frequently, become the seat of acute inflammation. The other affections to which they are liable will be noticed in their appropriate place.

The diseases of the gums and alveolar processes are divided by Mr. Bell into two classes: those which are the result of local irritation, and those which arise from constitutional causes.

Were it not for local irritation in these parts, the constitutional tendencies to disease would rarely manifest themselves; and, on the other hand, were it not for constitutional tendencies, the effects of local irritation would seldom be of a serious character. "Thus," says Mr. Bell, "the same cause of irritation which, in a healthy person, would occasion a simple abscess, might, in a different constitution, result in ulceration of a decidedly cancerous type, or in the production of fungous tumors, or the formation of scrofulous abscesses."

Each constitution has its peculiar tendency; or, in other words, is more favorable to the development of some forms of disease than others; and this tendency is always increased or diminished according to the healthy or unhealthy performance of the functional operations of the body generally. Thus, derangement of the digestive organs increases the tendency, in an individual of a mucous habit, to certain forms of diseased action in particular organs, and especially in the gums. A local irritant, which would otherwise produce only a slight inflammation of the margins of the gums, would now give rise to turgidity and sponginess of their whole structure. The same may be said with regard to a person of a scrofulous or scorbutic habit.

The susceptibility of the gums to the action of morbid irritants is always increased by enfeeblement of the vital powers of the body. Hence, persons laboring under excessive grief, melancholy, or any other affection of the mind, or under constitutional disease tending to enervate the vital energies of the system, are exceedingly subject to inflammation, sponginess, and ulceration of the gums. But, notwithstanding the increase of susceptibility which the gums derive from certain constitutional causes and states of the general health, these influences may, in the majority of cases, be counteracted by a strict observance of the rules of dental hygiene; or, in

other words, by constant and regular attention to the cleanliness of the teeth.

A local disease, situated in a remote part, often has the effect of diminishing the tendency in the gums to disease; but when, from its violence or long continuance, the general health becomes implicated, the susceptibility of these parts is augmented.

Although deriving their predisposition to disease from a specific, morbid constitutional tendency, they, nevertheless, when diseased, contribute in no small degree to derange the whole organism. Their unhealthy action vitiates the fluids of the mouth and renders them unfit for the purposes for which they are designed; hence, when these parts are restored to health, whether from the loss of diseased teeth or the treatment to which they may have been subjected, the condition of the general health is always immediately improved.

Thus, while the susceptibility of the gums to morbid impressions is influenced by the state of the general health, the latter is equally influenced by the condition of the former. And not only is a healthy condition of the gums essential to the general health, but it is also essential to the health of the teeth and alveolar processes. From the intimate relation that subsists between the former and the latter, disease cannot exist in one without in some degree affecting the other. Caries of the teeth, for example, often gives rise to inflammation of the gums and alveolo-dental periosteum; on the other hand, inflammation of these parts vitiates the fluids of the mouth and causes them to exert a deleterious action upon the teeth, and also excites more or less constitutional derangement.

ACUTE INFLAMMATION OF THE GUMS.

Acute inflammation of the gums frequently occurs in connection with stomatitis, or general inflammation of the mucous membrane of the buccal cavity, which appears under a great variety of forms. In this case the inflammatory action does not always extend to the subjacent fibro-cartilaginous structure; but the local disease is often complicated with other disorders, the treatment of which comes more properly within the province of the medical than that of the dental practitioner. Ulitis, or acute inflammation of the gums, is, in most cases, a purely local disease, arising usually from the irritation of dentition or as a consequence of periodontitis. It often extends to the submaxillary glands and muscles of the face, and is attended by swelling and other morbid phenomena. But as this form of inflammation of the gums is treated of in connection with other subjects, it will not be necessary to repeat what we have said elsewhere concerning it.

CHRONIC INFLAMMATION AND TUMEFACTION OF THE GUMS, ATTENDED BY RECESSION OF THEIR MARGINS FROM THE TEETH.

Chronic inflammation of the gums may exist for years without being attended with suppuration or recession of their margins from the necks of the teeth; but these phenomena are sooner or later developed, according to the amount of local irritation and the state of the constitutional health and habit of the body. With the occurrence of inflammation the margins of the gums gradually lose their festooned appearance, become thick, spongy, and rounded, and ultimately, on being pressed, purulent matter is discharged from between them and the necks of the teeth. Their sensibility is increased and they bleed from the most trifling injury.

The diseased action usually first develops itself in the gums around the lower front teeth and the upper molars, opposite the mouths of the salivary ducts, also in the immediate vicinity of aching, decayed, dead, loose, or irregularly arranged teeth, or in the neighborhood of roots of teeth; from thence it extends to the other teeth. The rapidity of its progress depends on the age, state of the general health, temperament and habit of body of the individual, and the character of the local irritant which has given rise to it. It is always more rapid in persons addicted to the free use of spirituous liquors, and in individuals in whom there exists a scorbutic tendency, or who have suffered from venereal disease, or from the constitutional effects of a mercurial treatment used to cure this or other diseases.

The inflammation may be confined to the gums of two or three teeth, or it may extend to the gums of all the teeth in one or both jaws.

As the disease advances, the gums begin to recede from the necks of the teeth, and the alveoli to waste, and the teeth, as they lose their support, loosen and ultimately drop out. In Fig. 105 is represented a case in which nearly one-half of the roots of the lower incisors have become exposed by this devastating process.

Fig. 105.

But the loss of the teeth, though it puts a stop to the local disease, is not the only bad effect that results from it. Constitutional symptoms often supervene, more vital organs become implicated, and the health of the general system is sometimes very seriously impaired. Hence, the improvement often observed after the loss of

the teeth, in the general health of persons whose mouths have for a long time been affected with this disease. No condition of the mouth has a greater tendency to deteriorate its secretions and impair the functions of mastication and digestion, than the one under consideration.

In forming an opinion of the injury likely to result from the disease, the dentist should be governed not only by the health and age of the patient, and the local causes concerned in its production, but he should also endeavor to ascertain whether it is connected with a constitutional tendency, or is purely a local affection. Some have been led to believe that the wasting of the gums and alveolar processes may sometimes take place without being connected with any special, local, or constitutional cause; that it is identical with that process by which the teeth of aged persons are removed, and that when it occurs in persons not past the meridian of life, it is symptomatic of a kind of premature old age.

The loss of the teeth, from the wasting of the gums and alveolar processes, although occurring frequently in advanced life, is not a necessary consequence of senility, for we occasionally see persons of seventy, and even eighty years of age, whose teeth are as firmly fixed in their sockets, and their gums as little impaired, as in individuals at twenty. We do not recollect ever to have seen a case of this kind in which there was not evidently some diseased action of the gums. But it is of little importance whether it be the result of old age, a constitutional tendency, functional derangement of some other part, or local irritation, since the consequences resulting from such loss are always the same.

The gums, after having been once the seat of chronic inflammation, are ever after more susceptible to the action of morbid irritants.

CAUSES.

The immediate or exciting cause of inflammation of the gums is local irritation, produced by salivary calculus, by carious, dead, loose, or aching teeth, or roots of teeth, or by teeth which occupy a wrong position, or that are crowded in their arrangement. It may also be produced by very hard teeth, which, in consequence of their density, possess only a very low degree of vitality; for cases of recession of the gums, in which a very slight inflammatory action exists, are frequently met with in individuals having teeth of this description. This can only be explained by supposing a want of congeniality between these organs and the more sensitive and highly vitalized parts with which they are in immediate contact. The

same thing is observed when the vitality of the teeth is weakened by age.

The secretions of the mouth, especially the mucus, are often rendered, by certain conditions of the general system, so acrid as to become a source of irritation to the gums.

Dr. Koecker, who had the most ample opportunities of observing this affection in all its various forms, says that he has never seen a case in which tartar was not present. That this is so in a large majority of the cases, there is no question; but that it is in all, is certainly a mistake. The author has met with many in which not the smallest deposit could be detected.

The disease attacks persons of every age, rank and condition; and in every country, climate and nation.

It is, however, more frequently met with in the lower than in the higher classes of society. Persons who pay no attention to the cleanliness and health of their teeth are particularly subject to it. With sailors, and those who live principally on salt provisions, it is very common. "Persons of robust constitution," says Dr. Koecker, "are much more liable to this affection of the gums than those of delicate habit; and it shows itself in its worst form after the age of thirty oftener than at any earlier period."

To the causes of irritation which have already been enumerated, may be added uncleanly habits, which cause the accumulation of extraneous matters on the teeth and along the edges of the gums, which decompose, producing irritation and increased vascular action, followed by congestion, stagnation, and general breaking down of tissue and the secretion of pus; also mercurial poisoning, scurvy, syphilis, a crowded dental arch, malignant impressions, artificial teeth badly inserted or made of improper material, and dental operations badly performed. The use of improper tooth-brushes and powders, especially charcoal, may be reckoned among its exciting causes. The irritability of the gums is sometimes increased by the use of acids; at other times it is diminished.

Every condition of the general system tending to increase the susceptibility of the gums to the action of local irritants favors the production of the disease. Everything that tends to induce such conditions may be regarded as a predisposing cause; such as bilious and inflammatory fevers, the excessive use of mercurial medicines, the venereal virus, intemperance and debauchery. Any deterioration of the fluids of the body is peculiarly conducive to it. Persons of cachectic habit are far more subject to it, and generally in its worst forms, than those individuals in the enjoyment of good health.

Strumous individuals sometimes have an affection of the gums

which differs in many respects from the one just described. The gums, instead of being purple and swollen, are pale and harder than ordinary, and, on being pressed, discharge muco-purulent matter of a dingy white color. They often remain in this condition for years without appearing to undergo any structural alteration, or to affect the alveolar processes. This form of the disease is principally confined to persons who have very white teeth; it is much less likely to attack males than females, and has never, so far as we have been able to ascertain, been mentioned by any dental writer. It rarely occurs before the age of eighteen or twenty, and it seems to be the result of impaired nutrition. The gums exhibit no signs of inflammatory action; on the contrary, they are paler, less sensitive, and possess less warmth than usual. It is never attended with tumefaction or absorption, except in its advanced stages.

TREATMENT.

In the treatment of inflamed, spongy, and ulcerated gums, the first thing claiming attention is the removal of the exciting causes. If there are dead or loose teeth in the mouth, or teeth which, from their position, act as mechanical irritants, they should be at once extracted. The remaining teeth should, at the same time, be freed from tartar and all other irritating depositions, in such a thorough manner as to permit none to remain, either about the necks or beneath the margins of the gums; and, if necessary, all deposits should be removed from about the very ends of the roots of the teeth, so far, at least, as the separation of the gums from the teeth extends. All necrosed portions of process should also be removed, and the entire surfaces of the exposed portions of the roots of the teeth be well polished. Besides removing the tartar, if the gums are much congested they should be scarified around the necks of the teeth and all hypertrophied growths in the interstices cut away. The bleeding which follows such operations should be promoted by frequently rinsing the mouth with warm water.

It is essential, in the treatment of the disease under consideration, that a decided impression be made upon it at once; consequently, no time should be lost in the removal of local exciting causes. "The advantage derived from this operation" (extraction of dead, loose, or irritating teeth), says Dr. Koecker, "would be either partly or wholly lost, were it performed at different periods." This observation has been verified by the author more than once. When he has been prevented, by the timidity of his patient, from extracting all the offending teeth at the first sitting, he has always found the cure much retarded, and, in some instances, almost entirely defeated.

Several sittings, however, are often required for the complete removal of the salivary deposit.

The cure may be hastened by washing the mouth several times a day with some tonic and astringent lotion. The author has found the following to be very serviceable:—

℞. Powdered nutgalls,			
" Peruvian bark,	each	2 drachms.	
" orris root,		1 drachm.	
Infusion of roses,		4 fluidounces.	

The infusion to stand for a day or so upon the powders, with frequent stirring; then decant and filter.

In mild cases of inflammation of the gums and mucous membrane of the mouth, iodine in glycerine—saturated solution—is an excellent application. For acute inflammation of the mucous membrane, the following recipes will prove very serviceable as gargles:—

℞. Potassæ chloras,			
Sodæ boras,	aa	ʒj.	
Aquæ,		℥ij.	M.
℞. Potassæ chloras,			
Alumina sulphas,	aa	ʒj.	
Aquæ,		℥iv.	M.
℞. Acidum tannicum,		ʒj.	
Potassæ chloras,		ʒij.	
Mel. rosa,		℥j.	
Aqua bulliens,		Oj.	M.
℞. Aquæ cologn.,		℥j.	
Tinctura capsici comp.,		ʒj.	
Sodæ boras,		ʒij.	
Tinct. cinchonæ,		℥ij.	
Tinct. pyrethri,		℥j.	
Aquæ,		℥iij.	M.

—*Garretson.*

We have, in cases where there was much soreness and ulceration of the gums, prescribed the following:—

℞. Borax,	2 scruples.
Honey,	1 fluidounce.
Sage tea,	4 fluidounces.

This is a favorite and very general domestic remedy, and will be found very soothing and healing.

For ulceration of the gums and mucous membrane of the mouth the following will prove excellent applications:—

℞. Acid. carbolic.,	ʒ ss.	
Glycerini,	℥ xv.	M.
℞. Sodæ boras,	ʒ ij.	
Glycerini,	℥ j.	
Aquæ,	℥ iv.	M.
℞. Acid. carbolic.,	gtt. v.	
Glycerini,	℥ j.	
Ol. caryophylli,	gtt. v.	M.
℞. Sodæ sulphis,	ʒ j.	
Glycerini,	℥ j.	M.

As a wash for the mouth, Dr. Fitch recommends a decoction of the green inner bark of white oak, which we have found beneficial. The following are recommended by Dr. Koecker as being very serviceable:—

"Take of clarified honey and of the tincture of bark two ounces each. Mix and dilute in the proportion of three tablespoonfuls to a pint of warm sage tea or water. It may be used frequently during the day.

"Take of honey and of the tincture of myrrh two ounces each. Mix and use as above."

For soft, swollen, and spongy gums, the French preparation known as *Phénol Sodique*—phenate of soda—a teaspoonful to a tumbler of water, will prove beneficial.

The pleasantest, and at the same time the most efficacious, mouth-wash which the author has ever employed is the following:—

℞. South American soap bark,	8 ounces.
Pyrethrum, Orris root, Benzoic acid, Cinnamon, each	1 ounce.
Tannic acid,	4 drachms.
Borax,	4 scruples.
Oil of wintergreen,	2 fluidrachms.
Oil of peppermint,	4 "
Cochineal,	8 drachms.
White sugar,	1 pound.
Alcohol,	3 pints.
Pure water,	5 "

Mix the ingredients thoroughly, digest for six days, and filter.

If, notwithstanding the use of the means here recommended, matter still be discharged from around the necks of the teeth, and should the gums continue spongy and manifest no disposition to heal, their edges may be touched with a solution of the chloride of zinc or nitrate of silver. This will seldom fail to impart to them a

healthy action. Either remedy may be used in the proportion of from one to three, or even six grains to one ounce of water. The most convenient mode of applying them, is with a camel's-hair pencil, and they will often succeed when other remedies fail. In those cases where the matter discharged from the edge of the gum has a nauseating and disagreeable odor, a preparation composed of carbolica cid f℥ij; oil of gaultheria, f℥ij, and aqua rosæ, f℥iij, of which ten to twenty drops may be added to a wineglass of water and used as a gargle, or applied on lint to the inflamed surface, is an excellent remedy for rendering the mouth comfortable. An excellent disinfectant in such cases is a gargle made by diluting a teaspoonful of chlorinated soda (Labarraque's solution) in four or eight ounces of water. Or it may be used much stronger, and applied with a small mop to the diseased parts; phénol sodique is also an excellent disinfectant.

While the means here directed for the cure of the disease are being employed, a recurrence of its exciting causes must be studiously guarded against. Tartar and foreign matter of every kind should be prevented from accumulating on the teeth, by a free and frequent use of a suitable brush and waxed floss-silk, until a healthy action be imparted to the gums; these should be used at least five times a day—immediately after rising in the morning, after each meal, and before retiring at night. The application of the brush may at first occasion some pain; but its use should nevertheless be persisted in, for, without it, all the other remedies will be of little avail. The friction produced by it, besides keeping the teeth clean, is of great service to the gums, in imparting to them a healthy action.

Treatment different from that here described is necessary in that form of disease which we noticed as being characterized by preternatural paleness and discharge of muco-purulent matter from between the edge of the gum and the neck of the tooth. In the first case of this disease treated by the author, he directed astringent and detergent lotions to be used; but these did not produce the desired effect. Having been led, from his observation in this case, to suspect that the disease was connected with some constitutional derangement, and was probably the result of a debilitated condition of the general system, he recommended, in the next case, the use of tonics and free exercise in the open air. This course, though attended with evident improvement of the general health, seemed to be productive of no benefit to the gums. They still appeared debilitated, and on being pressed discharged matter from beneath their edges. He advised a continuance of the tonics and exercise, and, with a view of exciting inflammation, touched the edges of the gums with nitrate of silver. This had the desired effect, and, as he had anticipated, a

new disease was substituted for the old one; for the cure of which he directed the mouth to be washed, five or six times a day, with the mixture of sage tea, alum, and honey, and at night and morning with salt water.

This treatment was perfectly successful. In about three weeks the gums assumed a healthy appearance, acquired their natural color, and the discharge of muco-purulent matter entirely ceased. He has since had occasion to treat several other cases, in all of which he adopted the same treatment, and with like success.

HYPERTROPHY, OR MORBID GROWTH OF THE GUMS.

The structural changes which take place in the gums as a consequence of increased vascular action are almost as various as are the constitutional tendencies of different individuals. Those characterizing the affection last noticed consist, for the most part, in increased thickness and recession of their edges from the necks of the teeth; but in the one of which we are now about to treat, there is morbid growth, which is sometimes so considerable that it almost covers the crowns of the teeth, thus interfering very seriously with the function of mastication. When thus affected, the gums have a dark purple color, with thick, smooth, and rounded margins, and discharge almost constantly from their inner surface a thin, purulent matter, which exhales an exceedingly offensive odor. They bleed profusely from the slightest injury, and are so sensitive that the pressure even of the lips is sometimes attended with pain. They are also affected with a peculiar itching sensation, which at times is a source of great annoyance.

The accompanying engraving (Fig. 106) will convey to the reader a more correct idea of the appearance of the gums when thus affected, than any description which can be given. It will be perceived from this that the morbid growth extends to the gums of all the teeth, as it usually does in this variety of diseased action.

Fig. 106.

Among the local and constitutional effects arising from the disease are offensive breath, vitiated saliva, destruction of the alveoli, with loosening and ultimate loss of the teeth, impaired digestion, with all its disagreeable concomitants, enlargement of the tonsils and bronchitis, together with a long train of other phenomena.

CAUSES.

The exciting cause of this peculiar affection is local irritation, produced by salivary calculus, dead, diseased, or irregularly arranged teeth; but the character of the structural alteration is evidently determined by some cachectic habit of body or constitutional tendency. It often attacks the gums of individuals whose teeth are sound and well arranged; but the author has never met with a case in which tartar was not present, though in some instances the quantity was so small as almost to lead one to doubt whether it could have had much agency in the production of the disease. But the susceptibility of the gums to morbid impressions in individuals liable to this affection is usually so great, that an irritant which under other circumstances would scarcely excite an increase of vascular action, gives rise, in cases of this sort, to the rapid development of an aggravated form of disease.

TREATMENT.

The first thing to be attended to in the treatment of the disease is the removal of all dead teeth, and such others as may in any way irritate the gums. The morbid growth should be next removed, by making a horizontal incision entirely through the diseased gums to the crowns of the teeth. This should be carried as far back as the morbid growth extends. After this the gums should be freely scarified by passing a lancet between the teeth down to the alveoli, in order that the vessels may be completely divided and discharge their accumulated blood. This should be repeated several times, at intervals of four or five days. Meanwhile the mouth may be washed three or four times a day with some astringent and detergent lotion, and occasionally mopped with a weak solution of chloride of zinc or nitrate of silver, one grain to the ounce of water. Phénol sodique—phenate of soda—either in its full strength or diluted with from one to twelve times its bulk of water, according to indications, proves very serviceable as a lotion, causing the rapid absorption of the extravasated blood, preventing fetor, and speedily healing and hardening the gums. The tartar should be removed as soon as the gums have sufficiently collapsed to admit of the operation.

In severe cases a permanent cure cannot be effected by the local treatment above described, for, in addition to the removal of the enlarged gum tissues, it may be necessary to excise the edge of the alveolus. Particular attention should be paid to the regimen of the patient and such general remedies prescribed as the peculiar nature of the case may indicate. Excess and intemperance of every kind

must be avoided. In cases of an inflammatory type, the diet should be chiefly vegetable; but where there is debility or other cachexia, animal food should be used, taking care to avoid all young meats, as veal or lamb, all gross meats, such as pork, and all salt meats or shell-fish. Fruits and acid beverages, such as infusions of malt and vinegar, lemon-juice, spruce beer, etc., may be used with advantage.

The teeth should be kept perfectly and constantly clean. Not a particle of foreign matter should be permitted to remain between them or along the edges of the gums. A scrupulous attention to this precaution is indispensably necessary, as it constitutes one of the most important remedial indications.

MERCURIAL INFLAMMATION OF THE GUMS.

Small and repeated doses of mercury, when carried to the point of salivation, frequently give rise to the development of peculiar morbid phenomena in the gums and other parts of the mouth. The first indication of the specific action of this powerful medicinal agent upon the animal economy consists in a slightly increased redness and tumefaction of the free edge of the gums, around the necks of the inferior incisors. There is a characteristic bluish color along the edge of the gums, while the investing mucous membrane of the adherent portion, a little lower down, often assumes a white color, owing to the opacity of the epithelium. These appearances are followed by increased secretion of saliva; a strong metallic taste; soreness of the teeth and gums; inflammation and swelling of the mucous membrane of the roof of the mouth, fauces and cheeks, and the salivary glands; swelling of the tongue, with increased redness of its edges, and a peculiarly offensive odor of breath. In the meantime, the edges of the gums about the necks of the teeth swell and assume an increase of redness; the saliva becomes viscid, and is secreted in such abundance as to flow from the mouth, and the movements of the jaws are attended with pain. The alveolo-dental periosteum is thickened, and the teeth raised from their sockets and loosened. A vesicular eruption sometimes appears, followed by ulceration and sloughing of the gums, and very frequently by necrosis of large portions of the alveolar process and maxilla. We were shown, a few years since, the entire alveolar border of both jaws, the necrosis and exfoliation of which had been occasioned by severe mercurial salivation; and we have frequently had occasion to remove portions both of the superior and inferior maxillary bones—the necrosis having been occasioned by the use of this medicine.

By the prudent administration of mercury, salivation may be in-

duced, without causing the deplorable effects just described. But the specific action of this agent upon the constitution is always attended by more or less tumefaction and sponginess of the gums, and when once brought under its influence, however perfectly its effects may have subsided, they are ever after more susceptible to morbid impressions. Again, it should be remembered that very many of these deplorable symptoms follow the use of mercurials, even where there is no intention to salivate. It is a powerful agent, capable of much good, but one which has been productive of untold mischief, especially upon the mouth and teeth. Doubtless life must be saved at the expense, if necessary, of the teeth. But the peculiar specific action of this medicine should forbid its constant and indiscriminate employment.

TREATMENT.

It is scarcely necessary to say, that until the use of the mercury is discontinued it will be impossible to control or even counteract its effects upon the gums; but in mild cases these usually soon disappear after the action which it has produced on the general system has completely subsided. When the gums continue spongy, the bowels should be kept open with Seidlitz powders or other saline cathartics, the patient restricted to a fluid farinaceous diet, and the mouth gargled several times a day with mild astringent lotions, to which it may sometimes be advisable to add a little laudanum. Benefit may be derived from the application of the officinal tincture of iodine in a solution composed of one-half water. For internal use, chlorate of potash and iodide of potassium are considered the best remedies in mercurial poisoning.

The chlorate of potash is also of very great service as a lotion, in the strength of one drachm to the ounce of water.

For internal use, ten grains of the chlorate of potash may be dissolved in half an ounce of water, and administered in four or five doses during the day. For an adult, Dr. Garretson recommends the following lotion as very beneficial in cases where the tumefaction is very great and indolent looking:—

℞.	Potassæ chloras,		℥ss.	
	Sodæ boras,			
	Alumen pulv.,	aa	ʒij.	
	Potass. permang.,		grs. xxv.	
	Aqua cologn.,		℥ss.	
	Tinct. cinchonæ,		℥ij.	
	Tinct. myrrhæ,		℥j.	
	Infus. quercus (fort.),		℥iv.	M.

SIG.—Gargle the mouth pro re nata.

The iodide of potassium may be given in doses of from three to five grains, three times a day, in some bitter infusion.

The following gargle will be found very serviceable in mercurial salivation :—

℞. Tinct. iodinii,	. . . .	ʒ iij to vj.
Potassæ iodidi,	. . . . . .	grs. xv. to xxx.
Aquæ,	. . . .	Oss. M.

After the action of the medicine upon the system has subsided, and the disease assumes a chronic form, the gums, as directed by Mr. Thomas Bell, should be freely scarified by passing a lancet entirely through their substance, between the teeth; and this operation should be repeated as often as every few days until they are completely restored. The use of astringent washes should at the same time be continued, and if there are any teeth which, from the loss of their vitality or from having become very much loosened by the partial destruction of their sockets, act as irritants they should be removed.

For correcting the fetor arising from the ulcerated surfaces, a gargle may be used composed of two or three drachms of charcoal suspended by agitation in a tumbler of water. After retaining a portion of this gargle for a short time, the mouth should be rinsed with warm water to remove the particles of charcoal.

A solution of the permanganate of potash, in the strength of from two to ten grains to the ounce of water, as a gargle, or of phénol sodique in the form of spray, or permanganate of potash solution will prove effective for the removal of the fetor; also washes made from chlorinated soda or lime.

ULCERATION OF THE GUMS OF CHILDREN, ATTENDED WITH EXFOLIATION OF THE ALVEOLAR PROCESSES.

The gums and alveolar processes of children are occasionally attacked by a very peculiar form of disease, which occurs more frequently during the shedding of the temporary and the eruption of the permanent teeth than at any other period of childhood. We have never known adults to be affected with it, and to the ordinary spongy, inflamed, and ulcerated gums it does not appear to be at all analogous. It bears a much closer resemblance to *cancrum oris*, yet differs in many particulars from this disease.

Among the symptoms which characterize the affection are itching and ulceration of the gums and their separation from the necks

of the teeth and alveolar processes; there is, at first, a discharge of muco-purulent matter from between the gums and necks of the teeth, which ultimately becomes ichorous and fetid. The teeth loosen, and the alveoli lose their vitality and exfoliate. Ulcers are formed in various parts of the mouth, and the gums and lips assume a deep red or purple color. In the exfoliation of the alveolar processes the temporary, and sometimes the crowns of the permanent teeth, are carried away. The constitutional symptoms are: skin, for the most part, dry; pulse, small and quick; the bowels generally constipated, though sometimes there is diarrhœa; and to these symptoms may be added lassitude and a disposition to sleep.

These may be regarded as the prominent phenomena of the disease in its most aggravated form. When exfoliation of the alveolar processes takes place, the symptoms usually abate, and sometimes wholly disappear. Delabarre says: "Among the great number of children that are brought to the orphan asylum, he has had frequent occasion to notice singular complications of the affection, as modified by the strength, sex, and idiosyncrasies of the different subjects." The gums and lips, in some, he describes as being of a beautiful red color; in others the lips are rosy and the gums pale, and sometimes very much swollen. He also enumerates among the symptoms, burning pain in the mucous membrane of the cheeks, and ulceration, pain and swelling in the submaxillary glands.

In the majority of cases the disease is confined to one jaw and to one side, though sometimes both are affected by it. The effect on the permanent teeth, in all the cases which have fallen under the notice of the author, was injurious, though Delabarre says that in children who have reached their seventh or eighth year the teeth are not injured, except that they may be badly arranged, in consequence of the want of a proper development of the jaw.

The author enumerates the following symptoms of a very aggravated form of this disease: inordinate appetite, burning thirst, a small spot on the cheek, or about the lips, resembling an anthrax, which rapidly increases in size, turns black, separates, discharges an ichorous fluid, and its edges roll themselves up like flesh exposed to the action of a brisk fire; the flesh separates from the face, the bones become exposed, hectic fever ensues, and in the course of fifteen or twenty days death puts an end to the sufferings of the child. Delabarre asserts that this affection is more common among females than males, and that the bones of the jaw are so much softened that they may be easily cut with a knife.

CAUSES.

The disease seems to be the result of general debility or defective nutrition and a cachectic habit of body. It appears to be almost wholly confined to children of the poor and destitute, and, so far as the author's observations extend, to those who reside in cellars or small and confined apartments. Children of scorbutic habit seem to be the most subject to it. From the great debility of all the organs of the body, their functions are languidly and imperfectly performed. That the disease is determined by general enfeeblement of the functions of the body there is, we think, little doubt; but whether it would develop itself independently of any local cause, is a question which we do not feel ourselves able satisfactorily to answer. It is not at all improbable that local irritants are the exciting cause; and we are the more inclined to this belief from the fact that in all the cases which have fallen under our observation the teeth were considerably decayed and had previously given rise to pain, and in some instances they were coated with tartar. While, therefore, the character of the affection is determined by some peculiar constitutional tendency and general enfeeblement of the vital powers of the body, it is not unlikely that local irritation is the immediate cause of its development.

TREATMENT.

As the treatment of this affection comes more immediately within the province of the medical than of the dental practitioner, we shall not dwell long upon the subject.

The local treatment should consist of acidulated and astringent gargles. The ulcerated parts may be occasionally touched with a solution of the nitrate of silver, or chloride of zinc, from three to eight grains to the ounce of water; phénol sodique or permanganate of potash solution may be employed to correct the fetor. As soon as the alveolar process exfoliates, it should be removed. After this takes place a cure is generally speedily effected under proper constitutional treatment. This last may consist of mild alteratives, a generous nutritive diet, consisting of succulent vegetables, and, in the absence of fever, of wholesome meats, tonics, and exercise in the open air. (See "Ulcerous Stomatitis.")

ALVEOLAR PYORRHŒA.

Alveolar Pyorrhœa, commonly designated "Riggs' disease," denotes suppurative inflammation of the gums, attended with the

destruction of the alveolar processes. It usually commences with an uneasy sensation in the gums and teeth, which soon become painful.

At an early stage of this disease the margin of the gum presents decided inflammatory action and bleeds from slight causes.

As the disease progresses, the inflammation extends deeper into the substance of the gum, which becomes greatly congested with venous blood, swollen, and exhibits a tendency to separate from the necks of the teeth, which gives rise to the formation of small sulci filled with pus. There is also a loss of substance of the gum, and the destruction of the margins of the alveolar processes is followed by the death of the thicker portions beneath, and, as a consequence, the teeth become loose and change their positions. There is frequently a separation and protrusion of the superior and inferior front teeth, with a thick, fetid discharge from about their necks, which causes a disagreeable taste and a very offensive breath. The gum at this stage of the disease is of a dark purple or livid hue, with a congested margin, and in some cases, on account of its being denuded of its epithelium, its surface presents a polished appearance; it may also become granular and covered with fungous excrescences. At an extreme stage of the disease, complete destruction of the alveoli and of a considerable portion of the gum occurs, and the teeth are held in place by a tough, ligamentous attachment, which was formerly the alveolo-dental periosteum. The roots of the teeth become coated with a layer of calculus, often of a greenish-brown color and great hardness, which adheres tenaciously, rendering its removal very difficult.

Although the two forms of calculus, the salivary, which is derived from the saliva, and the sanguinary, from the serum that exudes from the gums when diseased, cause inflammation of the peridental membrane, yet the latter form of calculus appears to be more commonly associated with this suppurative inflammation than the former.

The congestion and consequent recession of the gum from about the necks of the teeth permits the salivary form of calculus to be deposited on the roots, by the ready access afforded to the fluids of the mouth; while the pathological condition of the tissues in connection with the teeth, causes a serous exudation, the result of which is the deposit of the harder variety of calculus.

The nature of this calcic deposit is no doubt modified by the serous fluid from the gum.

CAUSES.

Although alveolar pyorrhœa is a disease depending almost wholly upon local causes, such as the irritation of salivary and sanguinary calculus, and especially this latter form of calcic deposit, and a perverted condition of the secretions, yet its peculiar manifestation, no doubt, often depends upon some unfavorable diathesis, which enables the local causes to produce more serious effects than might be possible in better systemic conditions. If the teeth are perfectly free from irritating accretions, and present smooth, polished surfaces at points where the more highly vitalized surrounding structures come in contact with them, no inflammatory action will occur in such structures. On the other hand, if the teeth, on account of calcic deposits about the margin of the gum and along their roots, act as irritants, inflammatory action, followed by such effects as the disease under consideration presents, may ensue. Low vitality and all diseases which affect the circulation may be named as predisposing causes of alveolar pyorrhœa.

Dr. Black, in describing this disease under the title of "phagedenic pericementitis," maintains that it is of local origin, while Dr. Atkinson ascribes it to constitutional causes. There is good reason, however, for believing that there are both predisposing and exciting causes for this disease.

TREATMENT.

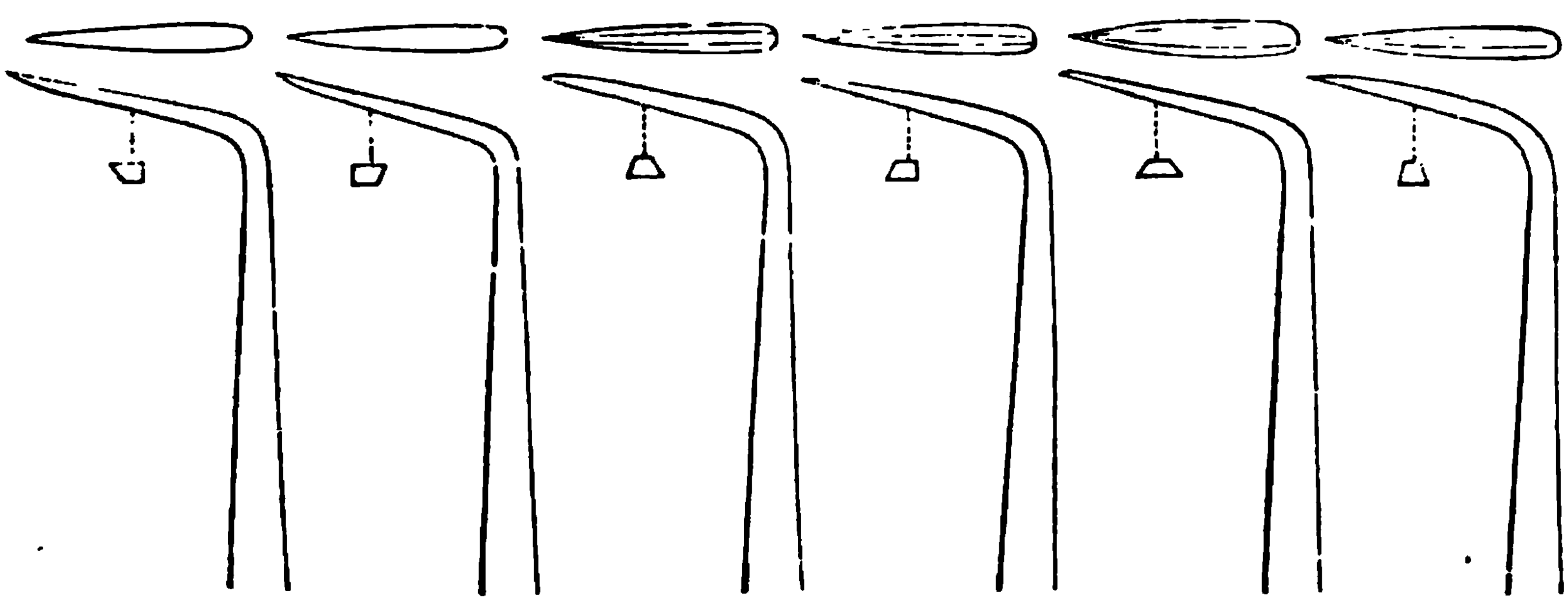
In the early stage of alveolar pyorrhœa all salivary deposition should be carefully removed and the surfaces beneath well polished; a decided change for the better may occur in a very short time, as the inflamed gum will lose its congested appearance, and assume a lighter color and a firmer consistence, and become reduced to its normal thickness. In the more advanced stages of this disease the treatment consists in reaching, by means of narrow, sharp instruments, the extreme limits of the diseased action, removing all deposits, and breaking up the diseased tissue and necrosed bone, and polishing the surfaces roughened by depositions of calculus.

The diseased margin of the alveolar process must be removed to such an extent that the firm and resistant bone is reached by the edge of the cutting instrument, which a nice sense of touch will determine.

A nice sense of touch, only acquired by practice, will enable the operator to distinguish, with the instrument, foreign and dead substance from tooth structure and living bone. It is especially necessary that every particle of salivary calculus and necrosed bone should be removed, as their presence will be indicated by a reddened

patch of tissue, somewhat larger than the irritant beneath. As the removal of such irritants causes both pain and hemorrhage, such an operation will require several sittings, and the frequent application of carbolic acid, by means of a properly shaped piece of orange wood. After this operation is completed an application of dilute aromatic sulphuric acid will prove serviceable. The effect of such treatment is to promote the reproduction of new bone, and cause the gum to become firmly attached to it, and thus restore the stability of the teeth, and in many cases the only therapeutic treatment necessary will be the use of an astringent wash, such as tincture of myrrh in its full strength, applied to the gum about the necks of the teeth. When constitutional disturbance exists in connection with the local effects, after perfectly removing all irritants, a dilute solution of chloride of zinc may be applied to the ulcerating surfaces by passing it under the gum, about the necks and roots of

FIG. 107.



the teeth, by means of cotton wound on a broach, and alternating with dilute aromatic sulphuric acid and tincture of iodine, applied to the surface of the gum. Chlorate of potash solution should be used as a mouth-wash after each meal and at night, with as thorough use of the brush as the condition of the gums will permit. The use of a solution of common salt is recommended during the intervals between the applications of the more powerful remedies; also phénol sodique.

For the worst stage of this disease, where the teeth are held in the mouth by means of the tough, ligamentous attachments only, their removal is inevitable.

The above illustration represents Dr. J. M. Riggs's set of instruments for the thorough removal of all salivary, sanguinary, and other deposits from the roots of the teeth, in the treatment of this disease.

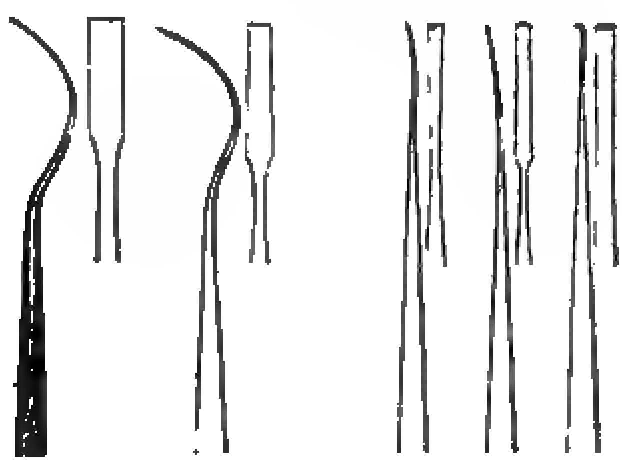
Some prefer instruments with slender points, which require a

pushing motion, instead of the curved hook or hoe-shaped instruments so commonly used for the removal of calcic deposits from the teeth, and which necessitate a motion toward the hand.

Whatever form of instrument is used, the thorough removal of all concretions from the teeth is absolutely necessary in this treatment, as all soft tissues are rendered unhealthy by the contact of calcic deposits. Dr. Cushing's set of scalers (Fig. 108) are well adapted for the removal of all calcic deposits from the teeth.

For the removal of slight deposits in the form of thin scales, Dr. Gilmer recommends that the gum be first expanded, so that it may stand off from the tooth, by packing under its free margin salicylized cotton, which is allowed to remain for twenty-four hours.

FIG. 108.



A method of treatment recently recommended by Dr. A. W. Harlan is as follows: For the acute form, the pockets formed by the separation of the gum should be first filled with iodoform and eucalyptus, iodoform and oil of cinnamon, or be thoroughly syringed with a one to three-grain solution to the ounce of water of chloride of alumina, which is a good disinfectant and astringent. In three or four days the sanguinary deposits may be removed, as well as the edges of the alveoli. The pockets should then be syringed with peroxide of hydrogen, for the purpose of thoroughly cleansing them and also to destroy the micro-organisms present. After drying the gums the pockets should be injected with a solution of iodide of zinc, grs. xii to grs. xiv to the ounce of water, two or three drops or more to each pocket. After several days have elapsed the gums should be carefully dried, and a fine cone of cotton or bibulous paper moistened with peroxide of hydrogen gently pressed into each pocket; if any pus is present effervescence will take place, when each pocket must be again injected with the iodide of zinc solution. In chronic cases, after the removal of the diseased bone

and the careful cleansing of the roots, the pockets should be syringed with peroxide of hydrogen, followed by the injection of a xxiv gr. solution of the iodide of zinc, in the same manner as before described. In very bad cases a stronger solution of the iodide of zinc is recommended, xxviii grs. to the ounce of water; and when the margins of the gums present a ragged border or cone-shaped slit, pure granular iodide of zinc is applied to the edges of the slit once in three days, the injection into the pockets being repeated every fourth day. Combinations of iodoform and eucalyptus, iodoform and oil of cinnamon, iodoform and eugenol, chloride of aluminum in the form of a solution composed of one to three grains to the ounce of water, sanitas, three parts to one part of eugenol, have also been employed with benefit, in the form of paste and injections once in four days.

A strong solution of chloride of zinc, 20 to 30 per cent., applied with care about the teeth by means of an abscess-syringe, will prove beneficial by relieving the congestion and constringing the soft tissues. The after-treatment consists in the use of stimulating applications, such as cinnamon-water, or carbolic acid combined with oil of cinnamon and oil of gaultheria, in the proportion of one drachm of the former and four to five drachms each of the latter. Cleanliness should also be observed, and in the use of the tooth-brush the motion should always be lengthwise instead of across the teeth—a soft brush being preferable to a stiff one. It is advisable, in cases where the destruction of the alveolar process has not been great, to preserve the gingival margin, in order that a perfect restoration of the peridental membrane may take place. Such an operation may be performed by introducing through the gingival aperture a bent chisel, or a hoe-shaped excavator, and the diseased structure removed as high up as it may extend toward the apex of the root. In cases where the cutting instrument cannot be introduced in such a manner without injury to the gingival margin, a flap of the soft tissue over the diseased bone may be raised, and all carious structure removed, as well as calcic deposits from the denuded root, through such an opening, without destroying the gingival margin. After the parts are thoroughly cleansed by injections of tepid water, stimulating applications may be made of carbolic acid (in crystals) one part, oil of cinnamon two parts, and oil of gaultheria three parts. Dr. Gilmer recommends for obstinate cases the use of carbolic acid and camphor, in the form of "phénol camphor," which consists of equal parts of carbolic acid and gum camphor, prepared by melting such a mixture on a sand bath until an oily liquid is obtained; it is applied by means of a syringe to the pus-pockets.

Before the application of disinfectants and antiseptics, the parts should be cleansed with the peroxide of hydrogen, either alone or combined with the bichloride of mercury.

ADHESIONS OF THE GUMS TO THE CHEEKS.

The gums and inner walls of the cheeks sometimes contract adhesions which interfere seriously with the functions of the mouth. The affection may be congenital, but in the majority of cases it occurs subsequently to birth. The extent of the adhesion may be small, or it may occupy the gums of the entire alveolar border of one or both sides of the mouth and of one or both jaws. Desirabode relates the case of a young man, who, in consequence of a venereal ulcer, had his upper lip united to the gums of the four incisors in such a way as to form a sort of loop above the teeth, which, by the retraction of the lip, were caused to project outward.*

Adhesion of the gums to the cheek or lips results from ulceration, caused either by constitutional disease or local lesions. But that it arises more frequently as a consequence of the immoderate use of mercury than from any other cause is a universally admitted fact. The author has met with several cases, however, in which the affection has resulted from ulceration of the gums around necrosed temporary teeth and of the corresponding wall of the cheek, caused by excoriation of the mucous membrane, produced by the sharp points of the protruding roots. But the extent of the adhesion, in cases of this sort, is never very considerable.

The proper remedy is to separate the parts which have grown together with a sharp bistoury. This done, reunion should be prevented by keeping a pledget of cotton or lint in the wound, until the process of cicatrization is completed.

CHAPTER V.

TUMORS OF THE MOUTH AND JAWS.

TUMORS of the gums are of various kinds; some interesting cases of simple hypertrophy are reported by Dr. Gross and Mr. Salter and Mr. Erichsen, which are reproduced by Mr. Heath in his admirable "Essay." Mr. Salter's case was found to consist of a pink-

* Author's translation of Desirabode's "Complete Elements of Science and Art of the Dentist," p. 227.

ish, corrugated and lobed mass, composed of an expansion of the alveolus, with "immense hypertrophy of the fibrous gum, and an exuberant growth of the papillæ of the mucous membrane." Dr. Gross's case was somewhat similar. Mr. Erichsen's was found, "on section, to consist of firm, fibrous stroma, containing much glandular tissue in its interstices, and covered on its surface by very large and vascular papillæ. The epithelial layer was of unusual thickness, but no abnormal epithelial structures were found in the growth, which was an example of true hypertrophy." (Heath's "Jacksonian Essay," 190.)

A peculiarity of this case was that the teeth were also hypertrophied. In each of these cases the diseased tissue was removed and the exposed surface cauterized.

Polypus is a simple hypertrophy of the interdental gum, or dental pulp, and is generally occasioned by the irritation of a worn-out or broken tooth with a ragged edge. In structure these growths are like the gum from which they arise. They seldom give much pain, except ulceration should take place. If simply cut away they are very likely to return, but if the tooth is removed and astringent or cauterant applications be made they give but little trouble.

Continuous pressure by gutta percha or other means will also control them.

Mr. Salter reports two cases of "Papillary Tumors of the Gums," consisting almost entirely of epithelium, arranged in filiform papillæ resembling those of the tongue. It is described as "a curious white mass, consisting of coarse, detached fibres, pointed and free at one extremity and attached at the other; in fact, it was a mass of papillæ, many of them nearly an inch long, and similar in shape to the 'filiform' papillæ of the tongue; their surface was shreddy and broken; among the elongated processes were a few rounded eminences like 'fungiform' papillæ, and these had a smooth and broken surface."

The term Epulis is usually applied to tumors springing from the margin of the gums, whatever their structural character. They most commonly spring from the gum between two teeth; as they continue to grow the base may increase also in size till it covers the alveolar bone, or it may undergo superficial development, the point of attachment undergoing but little change; in other words, it may possess a broad, flattened base or a narrow pedicle. In structure it bears a close resemblance to the gum, and sometimes has imbedded in it spiculæ of bone, which may have been detached from the alveolar bone, constituting the source of irritation which gave rise to the morbid growth; or it may have been a true osseous development; a portion of germi-

nal matter, having escaped from its true osseous relation, has been here arrested, established a false centre of growth, and undergone development, in obedience to the primitive impulse of the parent cell from which it was derived.

The accompanying figure, from Mr. Heath, is a typical epulis of the most common variety. It is seen to be a "firm, fibrous tumor," with "some fibro-plastic cells intermingled." This variety of epulis is not unusually attached to the periosteum of the alveolus, with projecting spiculæ of bone entering it from the maxilla.

Fig. 109.

(Fig. 90 of "Heath on the Jaws.")

Left to themselves, these tumors will often continue to grow, encroaching upon the tongue, hard palate, and teeth. They are thus made liable to injury by the teeth, and an ulcerated surface is in this way established, which discharges freely, occasions considerable pain, and may become the seat of hemorrhage.

A softer and more vascular variety is described by Mr. Hutchinson as consisting of fibrous tissue, in which are imbedded a large number of polynucleated cells of the myeloid variety. In the "Transactions of the Pathological Society" he thus describes them: "The epulis presented all the characters of myeloid growth in a most remarkable degree. Its section was very vascular, and showed hues varying from a deep red to buff, and a peculiar light-greenish tint of yellow (xanthoid of Lebert). Scattered in its structures were some detached masses of soft, spongy bone. Under the microscope were seen an abundance of the large polynucleated bodies characteristic of these growths, many of them being very irregular in shape and much branched." This form of epulis is most frequently connected with the interior of the alveolus, and hence more closely resembles the endosteal structures. When presenting an ill-conditioned and ulcerated surface, it closely resembles a malignant growth, but does not, as has been thought by some writers, pass into cancer.

Mr. Heath also describes a variety which he calls "giant-celled epulis," consisting of "large, irregular, disk-like cells containing numerous beard-like nuclei interspersed among the fibrous tissue." It presents a surface of uniform smoothness, of a dark-gray color, with numerous purple spots upon it. He considers it as holding a position intermediate between "fibro-cellular and myeloid tumors,"

and of a similar nature to the growths described by Otto Weber as "giant-celled sarcoma," and as a "fibrous form of cancer arising from bone" by Wedl.

Another form of epulis, resembling epithelioma, and of interest as showing that epithelioma may be developed in the gum as elsewhere, is thus described in a report by Mr. Bruce to Mr. Heath:—

"The surface of the tumor is covered with healthy mucous membrane. The interior of the tumor is whiter, firmer, and more compact than the surface, but there is no line of demarcation between the tumor and its mucous covering. The structure of the growth is distinctly glandular, very much resembling some form of compact adenoid tumor of the breast.

"At the point of attachment of the tumor to the parts beneath a remarkable transformation of the glandular into the epitheliomatous structure is seen. In one part of the section may be seen the cut ends of gland tubules, whilst in their immediate neighborhood are most distinct nests of true epithelioma, consisting evidently of concentrically arranged cells compressed from the centre upward."

Mr. Adams reports a similar case which resulted in death, the disease having reappeared in the skin after its removal.

It is often difficult to determine the causation of epulis, but they may often be referred to the irritation of broken or unsound teeth, or to fragments of the alveolar bone which become detached, or to outgrowths from the alveolus; most frequently, however, to roots of decayed teeth; hence, Mr. Heath thinks, the greater frequency of these tumors in women—five to three—they, having a greater dread of all surgical operations, are more likely to permit useless roots to remain in their mouths.

It is rarely fatal, but sometimes attains such size as to produce great deformity, pain, and embarrassment of the functions of mastication and deglutition.

For the treatment of epulis, nothing short of the entire removal of the tumor with its periosteal attachments, together with all decayed teeth, or even sound ones—when the disease seems inclined to reproduce itself—promises any good result. After excision, the actual cautery should be freely applied, for the double purpose of destroying all trace of the disease and of arresting hemorrhage.

Tumors of the hard palate are closely related to epulis, and papillary and epithelial forms are reported—the former presenting but little difference from tumors of the same character arising on the gum.

An epithelial tumor occurring on the hard palate is reported by Dr. Andrew Clark, which was described as "soft, elastic, and vas-

cular. The cut surface is of a dead-white color, distinctly granular, like rough honey, crumbly-looking, and studded with red or pink blotched parts sunk below the general level. On further examination it appears to be permeated by a kind of glairy substance (colloid matter), which helps, seemingly, to give coherence to the tumor. To the naked eye the tumor resembles in some respects a cephaloid or myeloid mass. To the latter it bears the greatest resemblance in general character, seat, and structure. The microscopic characters are those of epithelial cancer, epithelial cells in all stages of development and of the most various forms, together with a few nest-cells and fat. The mucous membrane over the tumor, though not continuous with it, presents the same structural characters. This decides the doubt between the epithelioma and myeloma." (Heath's "Jacksonian Essay," p. 208.)

Encysted tumors of the hard palate are also sometimes found, but they are rare, and require no special description in a work of this character.

These tumors, when epuloid in character, are to be treated in the manner already described. When the bone becomes affected, it also must be removed to such an extent as will leave an entirely healthy surface.

Unerupted teeth may also give rise to osseous tumors, requiring surgical interference. This is more peculiarly the case with the wisdom tooth, for a reason easily understood: the space nominally allotted it, between the second molar and the terminal point of the alveolar ridge, is often too limited for its eruption; endeavoring to make its way through the bone under such circumstances, the opposition it encounters is often sufficient to occasion great irritation and pain, and occasionally to entirely prevent its eruption. The retained tooth thus becomes a centre of irritative action, and may serve not only to determine the site, but the fact of such tumors. Mr. Tomes also relates a case in which the wisdom tooth was bound down by a "mass of enamel, dentine, and cementum, thrown together without any definite arrangement," which occupied the place of the second molar. Mr. Heath also records a case, reported by Dr. Forget, in which a tumor about the "consistence of ivory," covered everywhere with enamel, and about the size of an egg, occupied that portion of the jaw between the ramus and the first bicuspid. It was composed chiefly of enamel and dentine, with portions of cementum "dipping into the crevices" here and there, and was regarded by Dr. Forget as a "fusion and hypertrophy of the last two molars."

Again, one of the anatomical elements of the tooth may become

so hypertrophied as to constitute a troublesome disease and call for surgical interference. The cementum is most likely to undergo such change. M. Maisonneuve reports a case cited by Mr. Heath, in which the hypertrophied cementum attained the size of a pigeon's egg.

It is desirable, if possible, to remove all such morbid growths without injury to the bone in which they are implanted; but it may become necessary to excise that part of the jaw in which it is. All neighboring teeth which may possibly be associated with it should be removed.

Tumors of the antrum and upper jaw may be appropriately described together, the distinguishing characteristics being pointed out.

Polypus.—Growths of this character occasionally occur in the antrum, and are closely allied to the small cysts occurring in its mucous membrane; both are essentially a "hypertrophy of some element of the mucous or sub-mucous tissue. When the connective or areolar tissue predominates, the fleshy polypus is produced; when the glandular element is especially affected, we have the cystic form produced. Intermediately, when the fibrous element is very loose and we have some glandular hypertrophy, the semi-gelatinous polypus is produced, which closely resembles the nasal polypus." ("Jacksonian Essay," p. 210.)

Antral polyps are very vascular, and are sometimes the ushers of malignant disease. The diagnosis is exceedingly difficult until they have advanced sufficiently to break down the osseous wall somewhere; this most frequently takes place into the nose, through the thin nasal wall.

They should be removed as soon as ascertained to exist, and the troublesome hemorrhage which is likely to occur should be arrested by injections of a reliable styptic, in any strength which is not likely to give rise to trouble, if the opening is sufficiently large to permit its ready escape.

A single instance of a peculiar form of fibroid growth of the antrum is recorded by Mr. Heath, from whose work we take the following description by Mr. Bruce:—

"It appears to consist of a fine, soft, fibrous stroma, in which very numerous nuclear bodies and a few elongated fibre-cells are distributed. Its structure resembles that of the upper strata of a mucous membrane, from which it is probably an outgrowth. It consists of newly-formed fibrous tissue, and of the elements from which fibrous tissue is developed, and may, therefore, be classed among

the simple fibro-plastic growths as distinguished from the true myeloid tumors."

Fibrous tumors of the upper jaw are not unlike fibrous tumors found elsewhere. They are slow of growth, dense in structure, with interlacing, slender bundles of fibres, and are frequently lobulated. They commonly spring from the interior of the antrum or from the alveolus, and sometimes attain to an enormous size, crushing in the antrum or obliterating its walls by absorption, encroaching upon the orbit, destroying its floor, penetrating the nasal cavity, and, extending outward, conceal the teeth on the same side from view. Mr. Liston removed a tumor of this kind from the face of a lady, where it had arisen six years before, apparently from a blow received on the face, and had attained to an enormous size, covering the whole of that side of the face. Its smallest diameter was six inches. This tumor became of increased vascularity after the cessation of the catemenia at the regular monthly period, and bled slightly at these times from the adjacent parts of the gum. They are usually of an oval or rounded form, freely movable, and painless. When laid open they present a white, shining, ligamentous structure, and are composed of nucleated fibres. If left to themselves they may become softened in the centre and undergo disintegration, though Mr. Heath thinks they never suppurate except where they have been punctured in establishing a diagnosis. They may also undergo calcareous degeneration, but are never ossified.

Mr. Paget reports a case in which distinct pulsation, synchronous with the radial pulse, was felt. They rarely recur after removal, perhaps never when entirely removed. Mr. Weber thinks "they are usually connected with the lining of the Haversian canals," and advises that a portion of the bone be removed in all operations. Their origin is usually referred to the irritation of decayed teeth or to direct violence.

Fibro-cellular tumor, or osteo-sarcoma, is of softer consistence than the simple fibrous tumor; they are smooth, round, elastic tumors, of a yellowish color, and are infiltrated with a serous fluid. Unlike the simple fibrous tumor, they exhibit a strong tendency to ulceration, which sometimes serves to confound them with malignant growths, from which they are to be distinguished by the history of the case and the non-implication of the lymphatic glands. They are thus described by Sir Philip Crampton: "In the earlier stages of the disease the tumor consists of a dense, elastic substance resembling fibro-cartilaginous structure, but the resemblance is more in color than consistency, for it is not nearly so hard, and is granular rather

than fibrous, so that it '*breaks short.*' On cutting into the tumor the edge of the knife grates against spicula, or small grains of earthy matter, with which its substance is beset." Fibro-cellular tumors may undergo fatty or calcareous degeneration.

Recurring fibroid tumors occur, if at all, so rarely in the upper jaw, that any description is unnecessary in a work of this kind. The same may be said of vascular tumors.

Myeloid tumors are described by Mr. Paget as occupying an intermediate position between fibrous and fibro-cellular tumors. They are composed of parallel fibres, with fibro-plastic cells, and bear a close resemblance to "granulation cells in process of development into fibro-cellular tissue." On section they present a smooth, shiny, semi-transparent appearance; are of a pinkish or bluish color and of brittle texture. They usually occur in the young, are painless, and seldom recur. Externally they present a dark maroon color, quite characteristic. An excellent description of a tumor of this class is furnished Mr. Heath by Dr. Tonge, from which we make the following extract: "It was of firm consistence throughout, and on section presented a whitish appearance, with a small pink patch or two, and a whitish, creamy-looking juice could be scraped from the cut surface. . . . The fibrous element was much less abundant than the cellular, and consisted of white fibrous tissue, with numerous fine, curling fibres of yellow elastic tissue, and many small oval and rounded nuclei were imbedded in the fibrous structure. The greater portion of the tumor seemed to be composed of cells. These were mostly of an irregularly rounded form, often with pointed processes; and some shuttle-shaped and spindle-shaped, of a somewhat trapezoidal form, were not uncommon, while a few cells presented the character of those distinctive of myeloid tumors. All the cells contained one, and often two, very large and generally oval nuclei, with one, two, or three nucleoli, and a variable number of oil globules. The myeloid cells observed were of irregular outline and contained from three to five nuclei, with single or double nucleoli; one very large cell contained six nuclei."

Their formation takes place slowly, after the manner of cyst formation or other simple tumors. When the bone has been removed by absorption or otherwise they may be recognized by their characteristic color, and when a cyst forms within them, as sometimes happens, myeloid cells may be found in the fluid that escapes when it has been punctured, thus distinguishing it from cystic formations.

Cartilaginous tumors are of two kinds: simple, innocent, or benignant tumors, and tumors presenting a malignant appearance. Those of the first class present a round or ovoidal form, are smooth, hard,

of slow growth, and painless. Those of the second class grow with great rapidity, to a large size, and are of a malignant appearance.

Cartilaginous tumors occur on the upper jaw, but may affect it secondarily by extension from other parts.

Mr. Heath describes several specimens taken from St. George's and St. Bartholomew's Hospitals, in one of which the disease occurred on the inner side of the orbit, and two years later had pressed the superior maxillæ forward nearly an inch beyond the inferior, while the "bones of the face and orbit were extensively absorbed." In the other the superior maxillary bones were entirely absorbed, the cavity of the skull was invaded, and the brain pressed aside; it is attached to the soft palate below, and presses forward the walls of the nose in front. Mr. Paget relates a case in which the disease had existed nine years, was removed, but returned, and the patient died seven years after. "A section of the tumor showed that it was composed of an outer, hard, thin shell of bone, completely enclosing a morbid growth of spongy, cancellated structure, devoid of all appearance of carcinomatous or spongy disease." These growths are usually very slow, and when removed exhibit but a slight tendency to recur. Cases are reported in which the free local use of iodine has effected the absorption of tumors of this kind that had not yet attained a large size. They sometimes soften, disintegrate, slough, and establish fistulous openings, through which a jelly-like mass escapes.

Osseous tumors in their simplest form are but a hypertrophy of previously existing bone tissue. They are predisposed to by syphilitic and scrofulous affections, and sometimes their immediate origin may be traced to the irritation of imperfect teeth; in general, however, it is difficult to refer them to a determinate cause. They are of slow growth, painless, and closely resemble true bone in structure. Their slowness of growth, hardness, painlessness, and fixity are the characteristics on which a diagnosis may be based, though they are occasionally movable. Occasionally they ulcerate, and troublesome fistulous openings are established. When of a large size they may invade important organs, occasioning great trouble, as in the case reported by Mr. Hilton, where it invaded the orbit and by its pressure burst the ball of the eye.

Cancerous tumors of the upper jaw are, in Mr. Heath's experience, limited to the medullary form; other observers have, however, occasionally met with scirrhus. Mr. Hancock advanced the view that medullary disease does not begin in the antrum, but in the bones at the base of the skull. This view is refuted by the observation of Mr. Liston and others, who have shown that it unquestionably begins in the antrum very often. They are characterized by

rapid development, softness to the touch, and, when fully established, by a peculiar expression and sallow, putty-like appearance of the skin. In this situation it is seldom accompanied by glandular enlargement. By pressing upon the nasal duct it may occasion considerable œdema of the lower eyelid, with enlargement of the facial veins, from obstructed circulation.

For the cure of all solid tumors of the upper jaw there is but one remedy on which we can rely—the knife. All operative procedures should be resorted to at the earliest practicable moment, before the facial structures have been extensively invaded by the disease. When the disease is entirely removed, in even malignant growths, we may sometimes entertain a hope of permanent relief. To effect the removal of tumors in this situation various methods have been devised. Until 1826 surgeons usually contented themselves with the removal of so much of the disease as could be effected with the gouge and chisel; but about this time Mr. Lizars, of Edinburgh, proposed the removal of the entire superior maxilla, having previously secured the carotid artery. An opportunity to carry out his suggestion did not offer until December of the following year, when, in attempting this operation, the hemorrhage, notwithstanding the ligation of the carotid, was so great as to necessitate the discontinuance of the operation. In the meantime, without any knowledge of Mr. Lizars' suggestion, Mr. Gensoul successfully removed the upper jaw without securing the artery and with but little hemorrhage. Mr. Lizars afterward operated successfully, and the operation is now an established one. His incision was carried from the angle of the mouth to the malar bone, where, when more space was required, it was met by a short, vertical incision, and an incision was also made from the middle line of the lip to the nostril. Mr. Gensoul employed a vertical incision from the inner canthus to the angle of the mouth, which was met midway by another at right angles to it, letting fall on its outer extremity another vertical incision. The bone was then removed with the mallet and chisel. An obvious objection to these operations was the great deformity occasioned and the division of the facial nerve. To obviate these difficulties Sir William Fergusson suggested a plan, which has since been very generally adopted. It consisted solely in an incision from the middle line of the lip to the nostril, when, by stretching the integument, sufficient space was usually gained. If more, however, was required, the incision was carried up alongside of the nose to the inner canthus, and below the eye to the outer canthus; thus the facial nerve and artery were divided so high up as to give but little trouble, while the scars are most favorably situated (see Fig. 110).

After deflecting the skin, a small saw is passed into the nostril, with which the hard palate and alveolus are divided. The nasal and malar processes of the superior maxilla are next sawed nearly through, and the division completed with bone forceps. The bone is then grasped by the powerful forceps devised by Sir William Fergusson, and forcibly wrenched from its attachments to the pterygoid process and palate bones. The infra-orbital nerve is then divided, the soft palate carefully dissected from the detached bone, which is ready for removal, after which hemorrhage is arrested by ligatures and the actual cautery, and the wound closed with silver sutures. When the palate bone and orbital palate are not involved they may be spared by sawing horizontally above and below them respectively. Sir William Fergusson now prefers to avoid the removal of all healthy tissue by attacking the disease from centre to circumference with strong curved and angular bone forceps. Both superior maxillæ have occasionally been removed; but it is an operation so seldom required that a description of it is not called for in a work of this kind.

Fig. 110.

Tumors of the lower jaw do not differ in essential particulars from those already described. They are more readily diagnosed and safely removed than those of the upper jaw. Deaths are comparatively rare from operative procedures here. When the tumors are small they may be removed without incision of the lip by simply dissecting it from its attachment to the bone, turning it down, and removing the diseased portion with bone forceps. When a large body is to be removed the incision should be carried beneath the margin of the jaw, where the scar shall afterward be concealed from view. When the bone is exposed we should endeavor carefully to ascertain if the disease may not be removed with the external plate of bone alone; if this may not be done, the saw should be brought into requisition and the diseased structure removed. Amputation of the lower jaw is far more readily effected than of the upper. For

a detailed account of this operation the student is referred to more exclusively surgical works.

CYSTIC TUMORS, DENTIGEROUS CYSTS.

It must be remembered, in connection with diseases of the antrum, that it is of variable size, with walls of variable thickness. In youth the walls are thick and the cavity small. After attaining its maximum size in the adult it is found again to diminish with old age; it is larger in males than in females. But in adult life its capacity varies in different subjects, from one drachm to eight drachms, the average capacity being about two and a half drachms.

Suppurative inflammation, or abscess of the antrum, is commonly due to extension of inflammation from the teeth to the lining membrane of its cavity. The roots of the first and second molars not infrequently present prominences at the antrum, and sometimes the first molar roots are found extending into this cavity entirely uncovered by bone. It will, therefore, be readily seen how disease of the roots may prove a source of irritation and inflammation to the lining membrane of this cavity; but such direct communication is not necessary; and disease beginning in alveoli not in immediate relation with the antrum may extend through intervening bone and establish communication. Direct blows upon the face may also induce suppurative inflammation of its membrane, and it may also arise from "pressure during birth."

The symptoms are, pain of a dull character, shooting up the side of the face and head, rigors succeeded by irritative fever, with tenderness and swelling of the cheek. As the pus accumulates, the pressure to which it subjects the walls of the cavity, together with the vitiated nutrition occasioned by its presence, determines absorption of the bone and the discharge of the contained fluid through the opening thus established either into the orbit or by the side of the teeth. Before an opening is established, however, the orbital wall may become so dilated as to occasion partial blindness by displacement of the eye, or it may even induce an amaurosis which shall result in permanent blindness. Sometimes extensive necrosis is occasioned, affecting all the adjacent bones, as in the case reported by Mr. Salter, in which the "floor of the orbit, the upper-cheek portion of the superior maxilla, and the infra-orbital, and a large plate of bone from the inner (nasal) wall of the antrum, were involved." Dr. Mair, of Madras, reports a case in which death resulted in sixteen days, though apparently beginning as a simple ozæna. The post-mortem examination in this case revealed a condition of things that led Dr. Mair to conclude that it began as a "disease of the antrum, originating in

degeneration of the mucous membrane lining its cavity, or, perhaps, connected with the soft tumors which grow from the apex of the tooth and from the lining membrane of the root; secondarily, involving the ethmoid, lachrymal, palatine, and inferior turbinated bones of the left side, causing suppuration and disintegration, the purulent matter filling the cavity of the antrum extending toward the left nostril, causing ozæna, and upward into the orbit, behind the globe of the eye, pushing the eye outward and forward, the matter finding its way through the optic foramen to the anterior surface of the left hemisphere of the brain, there acting as a foreign body, exciting inflammatory action, terminating in cerebral abscess, causing convulsions, coma, and death." (Edinburgh Medical Journal, May, 1806.) Cases of such severity are, fortunately, rare; but they indicate the possibilities of the apparently most simple cases, as well as the line of treatment most likely to obviate such conditions and result.

Treatment.—In the simplest cases in which suppuration of the antrum is strongly suspected, we should at once remove all decayed teeth or roots, and even sound teeth, when found to be tender. If matter has not yet formed, the disease may then subside under the use of simple fomentations. It is safer, however, in most cases, to penetrate the antrum, preferably through the socket of the first molar, because of the greater depth of the socket; and this, too, without delay, care being taken to regulate the force so as not, by too great violence, to injure the floor of the orbit. Should the teeth be sound and it be desired to save them, an opening may be made through the alveolus above the gum. The cavity should be freely injected with tepid water, and subsequently with some slightly stimulating and antiseptic lotion; and care must afterward be taken to prevent the admission of foreign substances into the cavity.

In the more chronic forms of this disease the purulent accumulation takes place so slowly, and the consequent expansion is so gradual, that it is often mistaken for solid growths; and in many cases the diagnosis is of extreme difficulty; surgeons of distinction, having begun an operation for the removal of a solid growth, have been surprised to find their hands bathed in pus, whilst the supposed tumor disappeared from beneath them. In all cases in which the diagnosis is not perfectly clear an exploratory puncture should be made, and thus the difficulty is at once resolved.

Sometimes the pus is inclosed in a second bony investment, due to the ossification of the antral periosteum. When this occurs, it occasionally happens that the bone remains thickened long after the evacuation of the pus and the entire cure of the abscess, the

deformity, of course, remaining unaltered. It then becomes necessary to open the antrum and remove this ossified periosteum.

A clear or yellowish serous fluid is not unfrequently found in the antrum, which the older writers took to be a secretion of mucus, which, having failed to make its escape by the aperture between the antrum and the nostril, accumulated in such quantity as to occasion wasting of antral walls to such an extent as to permit the fluctuating mass to be felt at certain points. This fluid was found on examination to contain numerous flakes of cholesterine, as is the case in well-defined cystic growths, and, as it in no respect resembled mucus, recent writers have referred this form of disease to cystic formations.

The most recent and able writer on this subject, Mr. Heath, thus describes their mode of origin: "It is certain, however, that some of these cases, and very probably all of them, originate in the growth of a cyst, or cysts, within the antrum or in connection with the fangs of the teeth, which either grow to such a size as to be mistaken for the cavity of the antrum when opened, or break into the antrum by absorption of the cyst-wall, so that on subsequent examination no evidence of the cyst formation can be discovered."

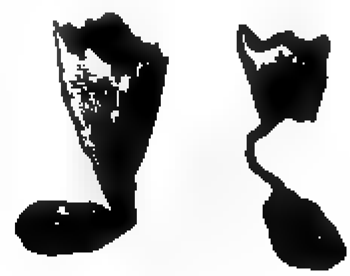
These cyst formations are also occasionally mistaken for solid growths, and Mr. Heath relates an instance in which "a very able surgeon removed the upper jaw before the mistake was discovered." And Sir William Fergusson relates a case in which a similar error was avoided by an exploratory puncture, which should in no case be omitted.

They may be single or multiple; sometimes there appears to be a "cystic regeneration of the entire mucous membrane." Mr. Giraldès, who was the first writer on this subject, thinks they are due to "dilation of the glandular follicles of the mucous membrane, and that in such cases it will be necessary to open the antrum, so as to remove the entire mass, it being useless in such cases to pursue the customary plan of tapping the antrum."

Cysts of teeth are divided by Mr. Heath into two classes: "First, cysts connected with the roots of fully developed teeth; and, secondly, cysts connected with imperfectly developed teeth—to which the term 'Dentigerous Cysts' has been applied in modern times." They occur indifferently in either jaw; in the upper, however, are sometimes complicated with collections of fluid in the antrum, which they have secondarily affected. When of very small size they give but little trouble, and are frequently found attached to the roots of teeth after extraction, where their existence had not before been suspected. They seem to occur most frequently in con-

nection with the incisor teeth, and sometimes attain a very large size, even when not communicating with the antrum. They are commonly associated with the disease of the root about which they are formed, whether as cause or effect it is difficult to determine, the majority of observers holding the latter opinion. Mr. Paget relates a case in which the cyst contained as much as an ounce of fluid, and was received in a deep depression in the alveolar border of the jaw. And Delpech reports one containing so much as three ounces, without connection with the antrum. They consist essentially of a serous bag growing from the dental periosteum at the extremity of the root, filled with a clear or yellowish fluid with bright shining particles of cholesterine floating about in it. According to Mr. Tomes the morbid process is probably identical with that resulting in the formation of alveolar abscess, but, being less acute, a serous cyst is formed instead of a suppurating one.

Fig. 111.



CYSTS CONNECTED WITH ROOTS OF TEETH.

Mr. Heath remarks that "large cysts produce more or less absorption of the outer wall of the maxilla, and are very common consequences of diseased teeth, but seem to give surprisingly little inconvenience to the patients, even when of large size and producing considerable deformity of the face. They are commonly confounded with cystic distention of the antrum."

Mr. Heath says "the clinical history of cysts connected with the teeth is that of painless expansion of the alveolus, more frequently of the upper jaw, with crackling of the bone on pressure and ultimate absorption of the bony wall. The cyst then presents a bluish appearance through the distended mucous membrane, and if large, gives distinct evidence of fluctuation." When an incision is made into the cyst a dark-colored, clear fluid escapes, but when inflammation is present the contents become purulent.

The treatment of such cysts consists in cutting away the thin outer wall, so that the cavity may granulate up.

Dentigerous cysts occur in connection with teeth, most commonly permanent teeth, in which the process of evolution has been arrested, and is due, Mr. Tomes thinks, to the accumulation of fluid between the enamel and soft outer tissue at the time when the enamel is completed, which fluid is usually discharged when the tooth is erupted; but when the tooth remains within the jaw this dis-

charge cannot take place, and it continues to increase in quantity until a cyst is established. We are thus enabled to account for the presence of cysts in those cases in which neither the tooth nor adjacent bone presents any appearance of disease. In illustration of this theory, Mr. Tomes relates a case in which, "instead of having the two fangs common to second molars of the lower jaw, the implanted portion of the tooth was dilated into one large concavity, in which was placed the crown of a second tooth, perfectly invested with well-developed enamel, and with the masticating surface directed toward the jaw. The two teeth appear to be united by dentine at one point, and to have one common pulp-cavity. . . . . I consider that in the case cited fluid collected between the enamel of the

FIG. 112.

DENTIGEROUS CYST OF LOWER JAW. *b*, Showing position of tooth.

inverted tooth and the remains of the enamel organ, situated within the socket of the second molar. As the cyst enlarged, the contiguous bone was absorbed to make room for it, and new tissue was concurrently developed on the outer walls of the socket till at last a large cup of bone was formed." ("Dental Surgery.")

When cysts of this kind occur in the lower jaw they present more obvious deformity. Sometimes the cyst undergoes calcification, and is exceedingly difficult to diagnose from a solid tumor.

Mr. Heath remarks that "the diagnosis of dentigerous cysts from other cysts is exceedingly difficult until they are opened, as, indeed, is the recognition of any form of cyst. A careful examination of the mouth may reveal the absence of a permanent tooth, or may show a

temporary tooth occupying a permanent position. On the other hand, however, it must be remembered that teeth may be wanting without being connected with any disease."

Many errors of diagnosis, leading to operations for the removal of supposed tumors, have been made by able and distinguished surgeons, who have had the courage and candor to confess their mistakes, among whom may be mentioned Gensoul, Syme, Feavu, and Lisfranc. The two latter gentlemen each removed half the jaw. It is only when the osseous walls have become so wasted as to give under pressure a parchment-like crackling that the diagnosis may be made with any approach to certainty. In every case an exploratory puncture should be insisted on before proceeding to operate. The existence of a cyst determined, and communication with the antrum suspected, the first molar tooth should be removed and the wall of the antrum be perforated through the socket, and if a supernumerary tooth is found in the cavity it should, of course, be removed. In many cases it is necessary to remove the front wall of the antrum and

FIG. 113.

INVERTED CROWNS OF TEETH BETWEEN EXPANDED ROOTS OF OTHER TEETH, CAUSING DENTIGEROUS CYSTS.

stuff the cavity with lint, thus inducing granulations, before a cure can be effected. This can generally be effected without incision of the integument. When feasible, the plate of bone removed should be left attached to the periosteum and be replaced after removal of the cyst.

Cysts in the lower jaw present some peculiarities which make a separate description necessary. They may occur in connection with fully developed teeth, or without any direct connection with the teeth. They may be multilocular, and in rare instances may contain one within another. Mr. Coote reports a case in an infant of six months—which resulted in death from exhaustion occasioned by continued discharge after an operation—in which, covered by a thin shell of bone, a perfect nest of cysts connected with the antrum have been shown to arise in the glandular structure of its lining membrane, but in the lower jaw we have no such membrane. Instead thereof we have two layers of laminated bone enclosing a cancellated structure lined by the endosteum alone. Mr. Heath is

of opinion that it is in these calculi the disease is developed, "A cancellus expanding and producing gradual absorption and obliteration of its neighbors until a cyst of considerable size is produced." The causation of cystic formations in the lower jaw is very obscure, though they are probably associated in some way with the irritation from adjacent roots. They may continue to reproduce themselves from time to time, until the cancellated tissue is entirely destroyed.

Cysts in connection with undeveloped teeth—dentigerous cysts—which are common to both jaws, may suppurate and form abscesses.

FIG. 114. FIG. 115.

DENTIGEROUS CYST DUE TO NON-DEVELOPMENT OF CANINE TOOTH.

They generally occur, in the case of unerupted teeth, from some irritation, and are more common to permanent than to deciduous teeth. Inversion of the tooth also appears to be a cause of these cysts.

Mr. Heath remarks that "when dentigerous cysts occur in the lower jaw they form more isolated and prominent tumors than in the case of the upper jaw, and in some cases the projecting bony wall has been removed."

The treatment of dentigerous cysts consists in a free incision and the removal of the unerupted tooth, as a simple puncture will not answer. The front wall of the cyst should be removed, and the cavity filled with lint, "so as to induce granulation and gradual obliteration." This may be accomplished in the majority of cases without any incision of the integuments. After the removal of a

portion of the cyst wall, in the case of dentigerous cysts of the lower jaw, the plates should be pressed together as much as possible; and the same may be accomplished in the case of the upper jaw by the pressure of pads and bandages. Mr. Heath directs that the cyst should always be reached by dividing the mucous membrane within the mouth, and without incising the cheek; but, if necessary, a single line of incision only should be made, so that as little after-deformity as possible may be produced.

Unilocular cysts are to be treated simply by extracting adjacent teeth, and, after evacuating the contents, when the walls are thin, crushing them in so as to diminish the size of the cavity. According to Mr. Eve multilocular cysts, so far from having a dental origin, are produced by an ingrowth of the epithelium of the gum. They may result from injury, the irritation of decayed teeth, or long-continued inflammation. They are of slow growth, and present very little tendency to implicate surrounding parts. Multilocular cysts are found in the lower jaw, consisting of cells varying in size from that of a pea to others occupying the entire thickness of the bone.

Multilocular cysts may be treated according to the plan of Mr. Butcher, which consists in dividing the mucous membrane over the cyst freely, and then with a gouge and the bone-forceps removing the expanded external plate of the bone, with the contents and lining membrane of the cyst, interfering with the teeth as little as possible and avoiding the facial artery. Dr. Mason Warren recommends a more conservative practice than that of Mr. Butcher. His treatment consists in the puncture of the sac within the mouth, and at the same time obliterating its cavity by crushing; then to keep up, by injections, etc., a sufficient degree of irritation to favor the deposition of new bone.

CHAPTER VI.

CALCIC DEPOSITS ON THE TEETH.

SALIVARY CALCULUS.

The color, consistence, and quantity of salivary calculus, or tartar, as it is most commonly called, vary in different temperaments, and upon all of them the state of the general health exercises considerable influence. The characteristics of this substance, therefore, furnish diagnoses important both to the physician and dentist. Their indications are, in many cases, less equivocal than the appearances

of any other part of the mouth; but, like those of the gums, should not, perhaps, be alone relied upon. It is necessary to interrogate every part from which information can be derived concerning the pathological condition of the several organs of the body.

Salivary calculus is composed of earthy salts and animal matter. Phosphate of lime and fibrine, or cartilage, are its principal ingredients; a small quantity of animal fat, however, enters into its composition, and the relative proportions of its constituents vary accordingly as it is hard or soft, or as the temperament of the individual from whose mouth it is taken is favorable or unfavorable to health. Hence it is that the analyses that have been made of it by different chemists differ. No two give the same result.

The black, dry calculus deposited around the necks of the teeth of such only as have good constitutions is never in large quantities; it is dissolved in muriatic acid with difficulty, while the dry, light-brown calculus found upon the teeth of bilious persons dissolves more readily in it; but the soft, white calculus found upon the teeth of individuals of neuro-lymphatic temperaments is scarcely at all soluble in the acids, but is readily dissolved in the alkalies.

All persons are subject to deposits of salivary calculus, but not alike; it collects on the teeth of some in larger quantities than on those of others, and its chemical and physical characteristics are exceedingly variable. It is sometimes almost wholly composed of calcareous ingredients; at other times these constitute but about one-half, or little more than one-half, of its substance, the remainder being made up of animal matter. Nor is its color more uniform. Sometimes it is black, at other times it is of a dark, pale, or yellowish brown, and in some instances it is nearly white. It also differs in density. In the mouths of some it has a solidity of texture nearly equal to that of the teeth themselves; in others it is so soft that it can be scraped from the teeth with the thumb- or finger-nail. The black kind is the hardest, the white the softest, and its density is increased or diminished as it approaches the one or the other of these colors.

Salivary calculus collects in very small quantities on the teeth of persons possessed of the most perfect constitutions, and even on these it is seldom found except on the inner surfaces of the lower incisors next the gums. It is then black, or of a dark brown, very dry, and almost as hard as the teeth, to which it adheres with great tenacity.

It rarely happens that any unpleasant effects are produced by the presence of this form of calculus upon the teeth. The general health is never affected by it, and the only local injury that results from it

is slight turgidity of the edge of the gums in immediate contact with it.

The indications, therefore, of this description of calculus are favorable, both with regard to the teeth, gums, and organism generally. The teeth upon which it is found are of an excellent quality and rarely affected by caries. They have the characteristics represented as belonging to the best kind, and teeth of this description are only found among persons having good innate constitutions.

There is another form of black calculus differing from this in many particulars. It is found in the mouths of those having good constitutions, but whose physical powers have been enervated by privation or disease, or intemperance and debauchery, and most frequently by the last named. It is found in large quantities on the teeth opposite the mouths of the salivary ducts; it is exceedingly hard, and agglutinated so firmly to the organs that it is removed with great difficulty; it is very black, has a rough and uneven surface, and is covered with a glairy, viscid, and almost insufferably offensive mucus.

The presence of this kind of salivary calculus is attended with very hurtful consequences, not only to the gums, alveolar processes, and teeth, but also to the general health. It causes the gums to inflame, swell, suppurate, and recede from the teeth, the alveoli to waste, and the teeth to loosen and frequently to drop out. The secretions of the mouth are also vitiated by it and rendered unfit to be taken into the stomach. Hence, as long as it is permitted to remain on the teeth, neither the skill of the physician nor the best regulated regimen, though they may afford partial and temporary relief, will fully restore to the system its healthy functions.

As this form of calculus is seldom if ever met with except in constitutions naturally excellent, the teeth on which it is deposited are generally sound, but they are often caused, by the disease which is produced in the gums and alveoli, to loosen and drop out.

The dark-brown calculus is not so hard as either of the descriptions of black. It sometimes collects in tolerably large quantities on the lower front teeth and on the first and second superior molars; it is also often found on all the teeth, though not in as great abundance as on these. It does not adhere with as much tenacity as either of the preceding kinds, and can be more easily detached from them. It exhales a more fetid odor than the first variety, but is less offensive than the second.

The persons most subject to this kind of calculus are of mixed temperaments, the sanguineous, however, always predominating. They may be denominated sanguineo-serous and bilious. Their

physical organization, though not the strongest and most perfect, may, nevertheless, be considered very good. But, being more susceptible to morbid impressions, their general health is less uniform and more liable to impairment than those possessed of the most perfect constitutions.

The effects arising from the accumulations of this description of salivary calculus, both local and constitutional, are less hurtful than the variety last noticed; but, like that, it causes the gums to inflame, swell, suppurate, and to retire from and expose the necks of the teeth, the alveoli to waste, the teeth to loosen and sometimes to drop out. It also gives rise to a vitiated condition of the fluids of the mouth.

Salivary calculus of a light or pale yellowish-brown color is of a much softer consistence than the darker varieties, and is seldom found upon the teeth, except of persons of bilious temperament, or those in whom this predominates. It has a rough and, for the most part, a dry surface; it is found in large quantities opposite the mouths of the salivary ducts, and sometimes every tooth in the mouth is completely imbedded in it. It contains less of the earthy salts and more of the animal matter than any of the foregoing descriptions, and, from the quantity of vitiated mucus in and adhering to it, has an exceedingly offensive smell. It is sometimes, though not always, so soft that it may be crumbled between the thumb and finger.

Inflammation, turgescence, and suppuration of the gums, inflammation of the alveolo-dental periosteum, the destruction of the sockets and loss of the teeth, and an altered condition of the fluids of the mouth are among the local effects produced by the long-continued presence of large collections of this variety of tartar. The constitutional effects are not much less pernicious. Indigestion and general derangement of all the assimilative functions are among the most common. When the deposit is not large, inflammation and sponginess of such parts of the gums as are in immediate contact with it, and fetid breath, are the principal of the unpleasant effects produced by it.

White calculus rarely collects in very large quantities, and though most abundant on the outer surfaces of the first and second superior molars and the inner surfaces of the lower incisors, it is nevertheless frequently found on all the teeth. Its calcareous ingredients are less abundant than those of any of the preceding descriptions. Fibrine, animal fat and mucus constitute by far the larger portion of its substance. It is very soft, seldom exceeding in consistence common cheese-curd, to which in appearance it bears considerable resem-

blance. Although it exerts but little mechanical irritation upon the gums, it keeps up a constant morbid action in them. Its effects, however, upon the teeth are far more deleterious than any other description of calculus. It causes rapid decay of the organs, and the fluids of the mouth are also vitiated by it.

It is only upon the teeth of persons of mucous habit, or those who have suffered from diseases of the mucous membranes, or those in whom these tissues have been more or less involved, that this kind of calculus accumulates.

Salivary calculus sometimes accumulates in very large quantities, giving to the mouth a most disagreeable and repulsive aspect, and imparting to the breath, not unfrequently, an almost insufferably offensive odor. Fig. 116 represents a set of teeth incrusted with it, and Fig. 117 a single tooth, presented to the author by Dr. W. Allen, of Massachusetts, with the largest accumulation of this substance he has ever seen in one mass. Its longest diameter is an inch and an eighth, its shortest seven-eighths, and its thickest five-eighths of an inch.

Fig. 116.

Fig. 117.

Imbedded in its substance is the entire crown and neck of a lower dens sapientiæ, which was removed with it. It is of a light-brown color, and weighs two drachms and seventeen grains.

The late Prof. Austen described an interesting case where every tooth, above and below, had been loosened by alveolar absorption caused by this deposit; no tooth having more than an eighth of an inch depth of socket, and some of them held only by an exceedingly tough attachment to the gum and periosteum. The calculus upon the lower incisors was equal to five times the size of the teeth, most of it being on the inside, and three-quarters of an inch thick at the base. A singular peculiarity in this case was the excessive pain of extraction. Small as was the attachment, it was uncommonly firm, and the patient, a working-man, was laid up with nervous prostration for two weeks after the operation.

CHEMICAL CONSTITUENTS OF SALIVARY CALCULUS.

Salivary calculus is composed of phosphate of lime and animal matter, combined in various proportions, accordingly as it is

hard or soft; consequently no two analyses will yield the same result.

Schehevetskey gives the following analysis. He found one hundred parts to contain:—

Water and organic matter,	22.07
Magnesium phosphate,	1.07
Calcium phosphate,	67.18
Calcium carbonate,	8.13
Calcium fluoride,	1.55
	100.00

Dr. Stevenson furnishes the following:—

	Friable soft calculus from molars.	Hard calculus from lower incisors.
Water and organic matter,	21.48	17.51
Phosphate of magnesia,	1.31	1.31
Phosphate of calcium, with a little carbonate and a trace of fluoride,	77.21	81.18
	100.00	100.00

Hard, dry tartar contains more earthy and less animal matter than the soft, humid tartar.

Chemical analysis reveals a large proportion of mucus, as is shown by the following table of Vaquelin and Langier:—

Phosphate of lime and a little magnesia,	66
Carbonate of lime,	9
Salivary mucus (including ptyalin),	13
Animal matter soluble in hydrochloric acid,	5
Water and loss,	7
	100

An analysis of saliva reveals water, ptyalin, fat, chloride of sodium, chloride of potassium, phosphate of lime, and sulphocyanide of potassium.

The infusoria of which M. Mandl says tartar is composed have their origin in the vitiated mucus which is always mixed with it.

Scherer detected with a microscope infusoria in large numbers in the saliva of a girl laboring under a scorbutic affection of the mouth; but the author is inclined to believe that they had their origin in the mucous secretions of this cavity, which are always mixed with the former fluid. They are more or less numerous, as the tartar is hard or soft, or in proportion to the quantity of mucus that enters into its composition.*

* Dr. Dwinelle gives a minute description of their appearance in the first number of the fifth volume of the American Journal of Dental Science.

ORIGIN AND DEPOSITION OF SALIVARY CALCULUS.

There formerly existed much diversity of opinion as to the source whence salivary calculus is derived, but it is now generally conceded that this deleterious concretion is a deposit chiefly from the saliva, with an admixture of mucus, as the analyses of both these secretions reveal the necessary materials in sufficient quantity to form it. Bidder and Schmidt make the phosphates and carbonates amount to very nearly one per cent. in the saliva. All that is necessary, therefore, is that the surfaces of the teeth should have a sufficient affinity for the substance in question to cause a nucleus, which, when once formed, the secretion continues until serious secondary effects are liable to result.

In most varieties of salivary calculus there is a notable superabundance of the phosphates and carbonates, while in others there is nearly forty per cent. of purely animal matter. Hence the difference in action upon them by acids and alkalies. Of the animal matter entering into the composition of salivary calculus, fibrin, animal fat, and mucus are in the largest proportion.

Of the existence of the elements of the composition of calculus in the saliva there can be no question. Chemical analyses of this fluid, direct from the glands, place all doubt upon the subject at rest. Thus it is seen that the chief earthy constituents which enter into the formation of this substance are contained in the saliva. It may also exist in solution in the mucous fluid of the mouth.

That the deposition of tartar may take place on one side of the mouth without a similar deposit on the opposite side furnishes no evidence in support of the doctrine which has been advanced, that it is an exhalation from the capillaries of the mucous membrane of the gums. The mastication of food is, with most persons, performed more on one side of the mouth than on the other; that this function prevents, in a great degree, the accumulation of tartar on the organs immediately concerned is a fact with which every dentist must be familiar. Hence its frequent collection on the teeth of one side and not on those of the other. And that it is ascribable to this circumstance is susceptible of positive proof. If, on the removal of the tartar from the teeth of a person in whose mouth it has collected only on those of one side, mastication be afterward altogether performed on this side, it will not reaccumulate on them; and if requisite attention to the cleanliness of the teeth on the other side be not observed, it will soon collect there, although these teeth had before remained free from it.

Again, it often happens that disease of a severe character is excited in the gums by the use of mercurial medicines and other

causes, and yet but a small quantity of tartar collects on the teeth; but that any condition of the general system, or of the mouth, tending to make the fluids of this cavity more viscid, promotes its formation, is undeniable. There are, however, some temperaments much more favorable to its production than others; and it is a well-established fact that the mucous membrane of those in whose mouths it accumulates in largest quantity is the most irritable, and the buccal most viscid. Again, if it were deposited by the mucous fluids of the mouth, it would collect in largest quantities on those teeth which are less abundantly bathed in the saliva; as, for example, the anterior surfaces of the upper incisors and cuspids, while those opposite to the mouths of the ducts which discharge this fluid into the mouth would be less liable to deposits of tartar than any of the other teeth; whereas the contrary is found to be the case.

The conclusion, therefore, appears to us irresistible, that this earthy matter is chiefly a salivary deposit and takes place in the following manner: It is precipitated from the saliva, as this fluid enters the mouth—especially when the secretion is sluggish—upon the surfaces of the teeth opposite the openings into the ducts from which it is poured. To these its particles become agglutinated by the mucus always found, in greater or less quantity, upon them. Particle after particle is deposited, until it sometimes accumulates in such quantities that nearly all the teeth are almost entirely incrusted with it.

As regards the points of deposit of salivary calculus, the greatest quantities are found opposite the mouths of the ducts of the salivary glands, upon the lingual surfaces of the inferior incisors, cuspidati and bicuspids, and the buccal surfaces of the superior molars. The necks of the teeth, about the free margins of the gums, afford favorable points for its collection, as here the saliva is longer retained and its calcareous ingredients precipitated than upon more exposed parts. It first collects about the necks of the teeth in semi-circular or crescent-like lines close to the enamel, under the edge of the gums, and a nucleus being once formed it rapidly encroaches upon the crown, where it is deposited more abundantly. Certain varieties of salivary calculus adhere to the necks of the teeth with great tenacity, and often progress as far as the apex of the root, until the teeth are deprived of their support and their roots left denuded and exposed. Salivary calculus is never deposited on the flesh, but only upon such substances as represent the teeth or form nuclei, as artificial teeth, for example. It is sometimes deposited in the ducts, which may be owing to a sluggish condition of the saliva,

in a form known as ranula, and has been removed in a mass as large as a hazelnut.

M. Robert presented to the Anatomical Society of Paris a hog's bristle, which had been forced into the duct of Wharton, densely covered with a thick salivary concretion.

From the fact that salivary calculus is often found upon parts where the saliva cannot be retained for any length of time, it is evident that it is sometimes precipitated as soon as this fluid enters the mouth.

EFFECTS OF SALIVARY CALCULUS UPON THE TEETH, GUMS, AND ALVEOLAR PROCESSES.

Although salivary calculus does not directly act injuriously upon the substance of the teeth, but, on the contrary, preserves the part it covers from the action of chemical agents, yet the effects of the presence of this substance are always pernicious, though sometimes more so than at others. An altered condition of the fluids of the mouth, diseased gums, and not unfrequently the gradual destruction of the alveolar processes, and the loosening and loss of the teeth, are among the consequences that result from it. But besides these, other effects are occasionally produced, among which may be enumerated tumors and spongy excrescences of the gums of various kinds, necrosis and exfoliation of the alveolar processes and of portions of the maxillary bones, hemorrhage of the gums, anorexia, derangement of the whole digestive apparatus, and foul breath, catarrh, cough, diarrhœa, diseases of various kinds in the maxillary antra and nose, pain in the ear, headache, melancholy, hypochondriasis, etc. So irritating is its presence that wherever it comes in contact with the gums and alveoli it causes their absorption, which in some cases may, at first, be attended with little or no inconvenience to the parties; while in others considerable inflammation, ending in suppuration of the gums, may result, extending to the mucous membrane of the mouth. Periostitis and necrosis of the alveolar processes are also results of the irritating action of this substance. The character of the effects, however, both local and constitutional, depends upon the quantity and consistence of the tartar, and upon the temperament of the individual as well as the state of the general health; the two former of these are determined by the two latter and by the attention paid to the cleanliness of the teeth. If this last be properly attended to, salivary calculus, no matter how great the constitutional tendency to its formation, will not collect in large quantity upon the teeth. The importance, therefore, of its constant observance cannot be too strongly im-

pressed upon the patient, especially in those in whom there exists a great tendency to its deposition.

The teeth and their contiguous parts suffer more from accumulations of this substance than almost any other cause. Caries is not much more destructive to them. When permitted to accumulate for any great length of time the gums become so morbidly sensitive that a tooth-brush cannot be used without causing pain; consequently, the cleanliness of the mouth is not attempted, and thus, no means being taken to prevent its formation, it accumulates with increased rapidity, until the teeth, one after another, fall in quick succession victims to its desolating ravages.

It sometimes not only undermines the constitution by occasioning discharges of fetid matter from the gums and corrupting the fluids of the mouth, but it also renders the breath exceedingly unpleasant and offensive. So nauseating and disagreeable is the odor which some descriptions of tartar exhale that the atmosphere of a whole room is contaminated by it in a few minutes.

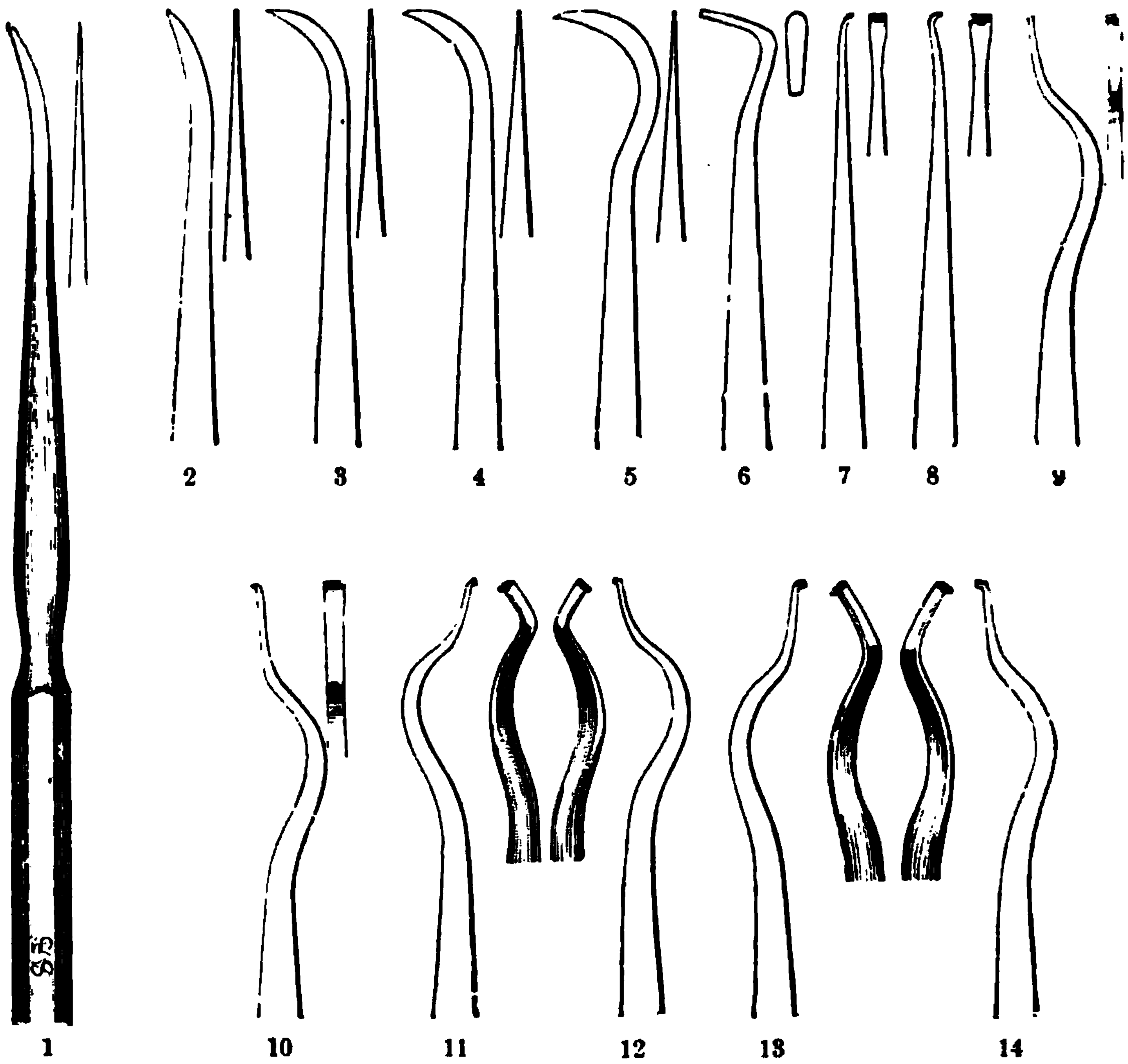
MANNER OF REMOVING SALIVARY CALCULUS.

This is an operation of great importance to the health of the gums, alveolar processes, and teeth. But from a misconception of its nature, rather than from fear of pain, many are much opposed to it; and, notwithstanding the universal admiration in which clean and white teeth are held, they will suffer the beauty of these organs to be destroyed rather than submit to its performance. There are some, indeed, who, though scrupulously particular in everything that regards dress, seem, nevertheless, to consider cleanliness of the mouth as unworthy of notice.

For the removal of tartar from the teeth a variety of instruments are necessary, which should be so constructed that they may be easily applied to every part of every tooth. Those in common use among dental practitioners are so very similar in their shape and so well known that we do not deem it necessary to point out the minute differences of construction, or even to give a general description of the instruments themselves. The instruments should be light, made with ivory, ebony, or cocoa handles, and tapering from a little above the ferule both ways; and the points of the instruments should be delicately shaped, so as readily to pass below the free edge of the gum. The success of the operation depends much upon the careful removal of every particle of deposit, for which a heavy, clumsy, or large-bladed instrument is wholly unsuited. If any particles of tartar be suffered to remain, they will irritate the gums and serve as nuclei for immediate re-accumulations.

Drs. F. Abbott's and How's sets of scalers, represented in the following figures, are well adapted for removing salivary calculus from all parts of the teeth.

FIG. 118.



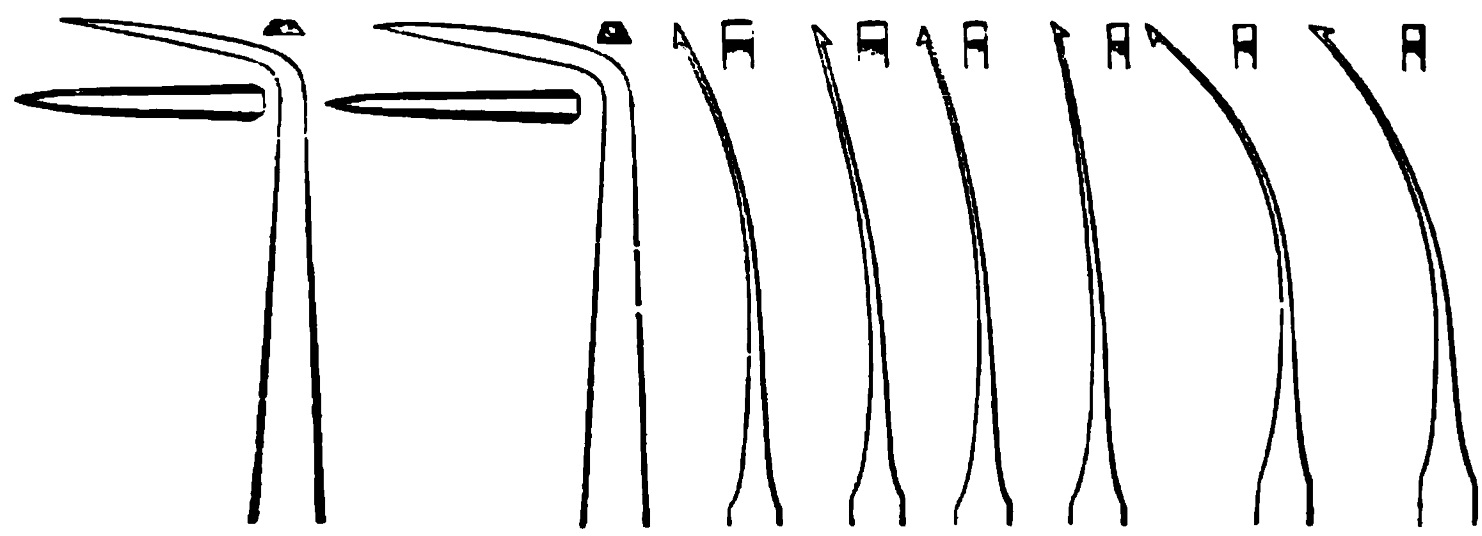
The adhesion of salivary calculus to the teeth is sometimes so great that considerable force is required for its removal, even when the sharpest and best-tempered instruments are employed, but ordinarily it may be removed with ease. Considerable tact, however, is necessary to perform the operation in a skillful manner; more than most persons, from its apparent simplicity, imagine. This skill can only be acquired by practice. Calculus may be taken from the outer and inner surfaces of the teeth without much difficulty, but the removal of it from between them is more troublesome, and can only be effected by means of very thin, sharp-pointed instruments. Many, however, prefer scaling instruments with slender points, such as are represented by Fig. 119, which are used with a pushing motion in a direction from the hand, instead of toward the hand. Fig. 120 represents a set of five scalers suggested by Dr. How.

In removing this substance from the teeth the point or edge of

the scaling instrument should be applied below the deposit, between it and the gum, and passed well under, until it comes in contact with the surface of the tooth, and the mass scaled off in the direction of the cutting edge or grinding surface.

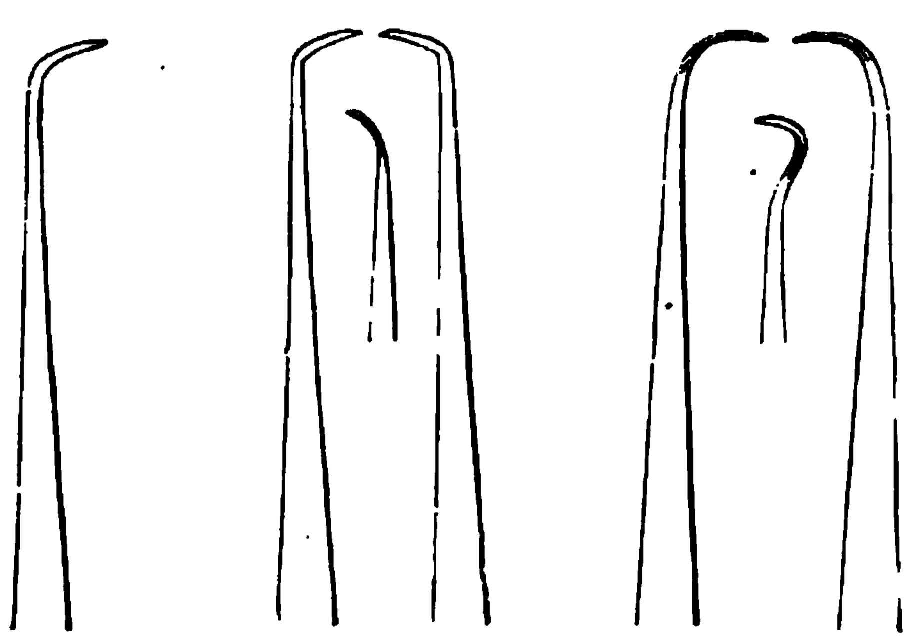
Care is necessary that the edge of the instrument does not roughen the tooth substance, especially the dentine, beyond the

FIG. 119.



enamel. After the removal of the greater part of the deposit, the instrument should be lightly passed over the surface, to detach any particles which may remain, especially upon the approximal surfaces. After the use of the scaling instruments finely pulverized

FIG. 120.



pumice or silex should be applied on a piece of orange wood so shaped as to reach all parts on which the deposit has collected.

The wood-points of various forms, charged with finely-powdered pumice or silex and rotated by means of the dental engine, are very useful for removing the discoloration caused by salivary calculus and the dark mucous deposit, which often cause the teeth to present quite an unsightly appearance.

The small tooth-polishing brushes represented by Fig. 121, and

the soft-rubber polishing cups suggested by Dr. J. B. Wood, Fig. 122, both operated by the dental engine, will cleanse teeth from remains of calculus after use of scalers and from discoloration, even under the free borders of the gums. The cervical margins of fillings may also be polished by the small brushes and cups.

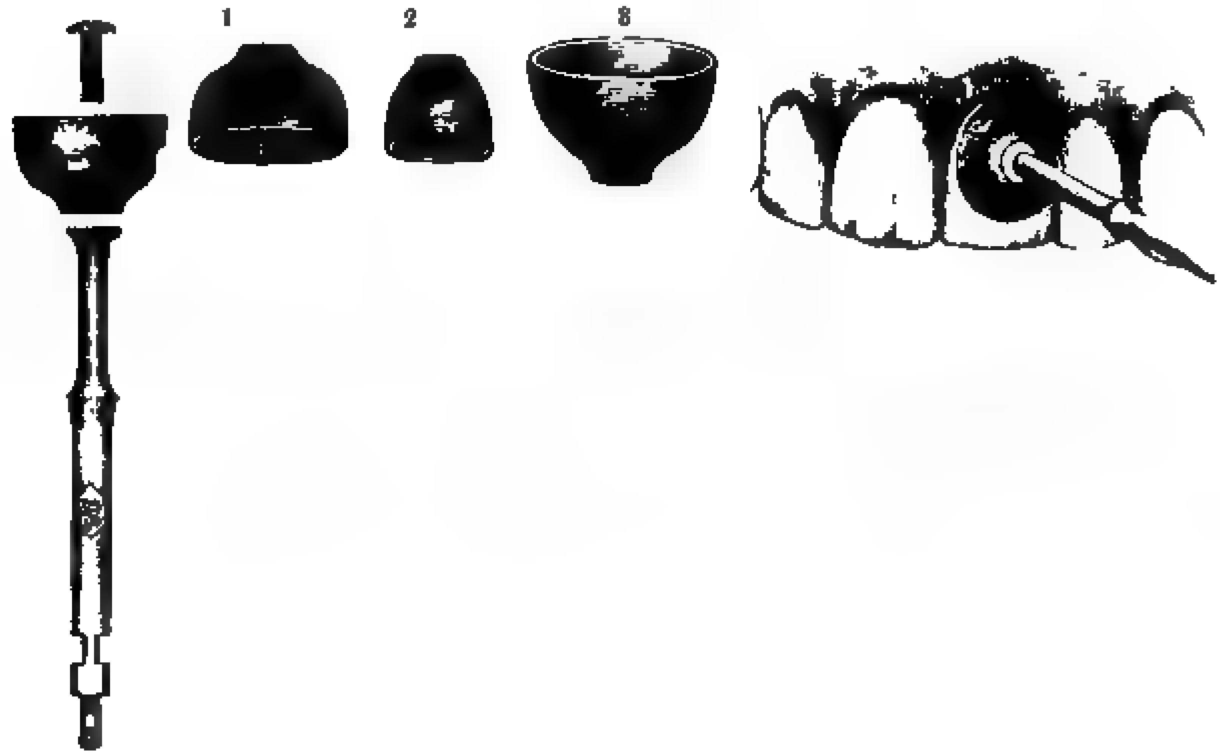
Where the surface of the enamel or dentine is found to be rough and without the natural polish, after the use of the pumice or silex,

FIG. 121.

Arkansas stone and the burnisher may be applied with advantage, and a finely polished surface obtained.

Several sittings are sometimes necessary for the completion of the operation, especially when the calculus has accumulated in very

FIG. 122.



large quantities. In all cases of this sort it should be first removed from between the edges of the gums and the necks of the teeth. During the intervals between the several operations the mouth should be gargled several times a day with some cooling and astringent wash; but on this subject more particular directions will be given in another chapter.

During the removal of calculus from the teeth the gums often bleed very freely; and when much swollen and spongy it may be well to promote it by holding tepid water in the mouth. When the lower incisors are loose, as is often the case, the operation should be proceeded with very cautiously, and the teeth supported by the fingers of the left hand holding the jaw, especially when the calculus is very hard and adheres with great tenacity.

Chemical agents are sometimes employed for the removal of salivary calculus, especially such of the vegetable and mineral acids as are supposed to have less affinity for the lime of the teeth than the phosphoric acid with which it is combined; but it is scarcely necessary to say that any acid capable of dissolving tartar will act upon these organs. The use of all such agents should be most scrupulously avoided. Nearly all acids, both mineral and vegetable, as has been shown in another part of this work, are prejudicial to the teeth. Their careless administration by physicians is a fruitful source of injury to the teeth. And they certainly should form no part of any dentifrice, or be in any way used for the removal of stains of any kind from the teeth.

SANGUINARY OR SERUMAL CALCULUS.

By this title Dr. L. C. Ingersoll designates a structureless calcareous deposit found at the apex of the root of a tooth, or sometimes extending in a line of granules along the root from the apex to the neck of the tooth, or again encircling the root immediately beneath the free margin of the gum. Being of a sanguinary origin, it is found only where the serum of the blood is present, which, being decomposed, gives up its lime salts and affords material for the deposit, which is stained with the hematin of the blood. This form of calculus is derived from the serum that exudes from the diseased tissue, and its superior hardness is due to its being more purely mineral than salivary calculus, and it is generally of a black or dark-green color. Sanguinary calculus is deposited upon the roots of the teeth, and not upon their crowns, as with salivary calculus, being often found upon the very apex of the roots. It also differs in another respect from salivary calculus; the sanguinary, resulting from the disorganization of blood and ulceration of tissues, is in the form of dark, hard granulations approaching crystallization. The root of the affected tooth is denuded of its cementum, and the granular deposit so closely adheres that its removal is quite difficult. Sometimes it is found immediately beneath the margin of the gum, in the form of a dark, hard, rough ring, which may occasionally be visible through the gum in the form of a dark circle. A viscid, serous

fluid may exude from about the neck of the tooth under slight pressure, the result of the ulceration which gives rise to the deposit. This fluid is not of the same nature as the pus from an abscess, being watery and nearly odorless, and composed, in a great part, of the serum of the blood. While salivary calculus causes inflammation, sanguinary calculus is a result of inflammatory action, and is found upon teeth affected with ulceration. The method of removing sanguinary calculus is referred to in the treatment of alveolar pyorrhœa.

MUCOUS DEPOSIT ON THE TEETH.

While persons of all ages are subject to deposits of salivary calculus, there is a mucous deposit to which the teeth of children are especially liable, in the form of a brown or a green stain, which has been erroneously called green tartar. This deposit is generally found upon the labial surfaces of the front teeth, more especially upon those of the upper jaw, and varies in color from a light brown to a dark green. From its not collecting upon the posterior teeth and upon the lingual surfaces of the inferior front teeth opposite the mouths of the ducts leading from the salivary glands, there is every reason to conclude that this deposit is not precipitated by the saliva, and hence is altogether different in its origin from salivary calculus. It is generally considered to be a deposit from the mucus, when this secretion is in a more acid condition than is natural. From its effects upon the teeth when it is allowed to remain on them for a considerable time, and also from the fact that it is most abundant when the mucus is secreted in large quantities and of a decidedly acid reaction, there is little doubt as to its origin from this secretion.

That it is not deposited on all parts of the teeth, is no reason for doubting the correctness of this theory, when we consider that the parts upon which it is found are those protected from the friction of food and the movements of the tongue and the flow of the saliva.

This form of discoloration of the enamel is indicative of an irritable condition of the mucous membranes and viscidity of the fluids of the mouth. Sour eructations, vomitings, diarrhœa and dysentery are not infrequent with those whose teeth are thus affected. While the presence of this green stain on lately erupted teeth is almost a certain indication of softened enamel, this is not the case when it is deposited on adult and very dense teeth. It does not appear to be a precipitate from the mucus, as salivary calculus is from the saliva, but is rather a growth of fungi upon the surface, and it is yet an open question whether it develops its own acid, as in the case of the

"sprosspilz" lately described by Dr. Miller, or whether it retains the neutral secretions to the acidulated stage.

According to Wedl, it may "readily be demonstrated that the deposit is a green, greenish-yellow, uniformly minutely granular mass which is morphologically identical with the matrix of the leptothrix."

In regard to the effects of this mucous deposit upon the teeth, while salivary calculus tends to preserve the portion of tooth-substance on which it is precipitated, this green stain so erodes the enamel that decay advances in the part which it covers, more or less rapidly; according to the quality of the teeth and the length of time it is allowed to remain. The removal of this mucous deposit requires more skillful manipulation than that of salivary calculus, on account of its being a thin film entering into the substance of the enamel, rendering it difficult to detach without injury to the tooth substance; whereas salivary calculus is deposited in such quantities as to leave thick incrustations, which are readily scaled off from an uninjured surface. Where the erosion caused by this mucous deposit is but slight, it may be removed by Arkansas or Superior stones, or by finely powdered silex or pumice stone and water applied on a stick of hard, fine-grained wood, such as orange wood or hickory; the point of the piece of wood being so formed as to adapt it well to the surface on which it is to be used. The wood-points or small brushes, or soft rubber cups, charged with either of the powders referred to, and rotated by means of the dental engine, will prove very serviceable for such an operation. After all the discoloration is removed by the means just referred to, the surface should be well burnished with a steel burnisher and a solution of pure Castile or white Windsor soap. When, however, the effects of this mucous deposit are more serious, the enamel not only being discolored but deeply eroded, it is necessary to make use of the corundum point, rotated by means of the dental engine, the enamel chisel or file, to remove the injured surface. The enamel chisel is to be preferred to the file in all cases where it is applicable; and the plain surface thus obtained should be polished with fine silex or pumice stone, Arkansas or Superior stones, and the burnisher. Care is necessary in the use of the enamel chisel, to avoid wounding the neighboring soft tissues. To prevent the possibility of such an accident and to enable the operator to have control over his instrument, the chisel should be held firmly with the hand in such a manner as to allow the thumb to rest on an adjoining tooth. When the dentine is very sensitive, as is frequently the case, a proper agent for allaying the sensitiveness may be applied from time to time to the surface, as the operation of cutting it away proceeds. (See "Treatment of Sensitive Dentine.")

CHAPTER VII.

THE FLUIDS OF THE MOUTH.

IN treating upon the physical characteristics of the fluids of the mouth, it will not be necessary to dwell at much length on their effects, when in a morbid condition, on this cavity. Concerning their agency in the production of caries of the teeth we shall add one or two remarks.

Saliva, in healthy persons having good constitutions, has a light, frothy appearance, and but little viscidity. Inflammation of the gums, from whatever cause produced, increases its viscidity and causes it to be less frothy. In a healthy state it is inodorous, floats upon and mixes readily with water, but when in a viscid or diseased condition it sinks and mixes with it with difficulty.

Irritation in the mouth, from diseased gums, aphthous ulcers, inflammation of the mucous membrane, the introduction of mercury into the system, or taking anything pungent into the mouth, increases the flow of this fluid and causes it to be more viscid than it is in its natural and healthy state.

In treating on the symptomatology of saliva, Prof. Schill says: "The sympathetic affection of the stomach in pregnancy is sometimes accompanied by salivation, which, in this case, mostly takes place after conception, and sometimes continues to the time of delivery. It is also observed to occur in weakened digestion, in gastric catarrhs, after the use of emetics, in mania, in what are called abdominal obstructions, in hypochondriasis and hysteria; salivation occurs during the use of mercury or antimony.

"In confluent smallpox, salivation is a favorable sign. If it cease before the ninth day the prognosis is bad. In lingering intermittents salivation is sometimes critical; more frequently in these affections it precedes the termination in dropsy.

"Diminution of the salivary secretion, and in consequence of this dryness of the mouth, is peculiar to the commencement of acute disease, as also to the hectic fevers occasioned by affections of the abdominal organs. If the flow of the saliva stop suddenly there is reason to apprehend an affection of the brain.

"Thick, viscid saliva occurs under the same circumstances as the diminution of the salivary secretion, especially in smallpox, typhus, and in hectic fevers. It is thin in ptyalism. In gastric diseases, where the liver participates, it becomes yellow or green; by the admixture of blood it may assume a reddish color; in pregnant or lying-

in women, it is sometimes milky; an icy-cold saliva was observed by the author in face-ache.

"Frothy saliva from the mouth is observed in apoplexy, epilepsy, hydrophobia, and in hysterical paroxysms."

Dr. Bell, of Philadelphia, in a note to the work from which we have just quoted, says, "Acid saliva is regarded by M. Donné as indicative of gastritis, or deranged digestion. Mr. Laycock," he observes, "on the other hand, infers, from numerous experiments on hospital patients, that the saliva may be acid, alkaline, or neutral, when the gastric phenomena are the same. In general, Mr. L. remarked that it was alkaline in the morning and acid in the evening."

We have had occasion to observe that the acid quality of the saliva was more apparent and more common in lymphatic, mucous, and bilious dispositions than in sanguineous or sanguineo-serous persons, and that weakened or impaired digestion always had a tendency to increase it.

M. Delabarre says, "When this fluid (the saliva) has remained in the mouth some moments, it there obtains new properties, according to each individual's constitution and the integrity of the mucous membrane, or some of the parts which it covers.

"In subjects who enjoy the best health, whose stomach and lungs are uninjured, the saliva appears very scarce, but this is because it passes into the stomach almost as soon as it is furnished by the glands that secrete it. It only remains long enough in the mouth to mix with a small quantity of mucus, and absorb a certain portion of atmospheric air to render it frothy.

"On the other hand, the saliva of an individual whose mucous system furnishes a large quantity of mucus, is stringy and heavy; is but slightly charged with oxygen, contains a great portion of azote and sulphur, and stains silver."

Increased redness and irritability of the mucous membrane of the mouth is an almost invariable accompaniment of general acidity of these fluids. Excoriation and aphthous ulcers, and bleeding of the gums, also frequently result from this condition of the salivary and mucous secretions of this cavity.

Anorexia, languor, general depression of spirits, headache, diarrhœa, and rapid decay of the teeth are very common among persons habitually subject to great viscidity of the buccal fluids. It is likewise among subjects of this kind, and particularly when the viscidity is so great as to cause clamminess of these secretions, that the green discoloration of the enamel of the teeth is most frequently met with.

CHAPTER VIII.

CHARACTERISTICS OF THE LIPS.

THE indications of the physical characteristics of the lips are more general than local, and the observations of Laforgue and Delabarre on this subject leave little to be added. We cannot, therefore, do much more than repeat what they have said.

"The lips," says Delabarre, "present marked difference in different constitutions. They are thick, red, rosy, or pale, according to the qualities of the blood that circulates through their arteries."

Firmness of the lips and a pale rose color of the mucous membrane that covers them are, according to Laforgue, indicative of pure blood, and, as a consequence, of a good constitution. Redness of the lips, deeper than that of the pale rose, is also mentioned as one of the signs of sanguineo-serous blood. Soft, pale lips are indicative of lymphatico-serous dispositions. In those subjects the lips are almost entirely without color. When there is a sufficiency of blood the lips are firm, though variable in color, according to the predominancy of the red or serous parts of this fluid.

Both hardness and redness of the lips and all the soft parts of the mouth are enumerated among the signs of plethora. Softness of the lips, without change of color in their mucous membrane, is spoken of by the last author as indicative of deficiency of blood; and softness and redness of the mucous membrane of the lips are signs that the blood is small in quantity and sanguineo-serous.

Deficiency in the red corpuscles and in the nutritive qualities of the blood is evidenced by the want of color and softness of the lips, and general paleness of the mucous membrane of the whole mouth. "The fluids contained in the vessels," says Laforgue, "in forms of anæmia, yield to the slightest pressure, and leave nothing between the fingers but the skin and cellular tissue."

In remarking upon the signs of the different qualities of the blood, the above-mentioned author asserts that the constitution of children about six years of age cannot be distinguished by any unusual characteristics, but that the lips, as well as the other parts of the mouth, constantly betoken "the quality of blood and that of the flesh;" and, "consequently, they proclaim health or disease, or the approach of asthenic and adynamic disorders, which the blood either causes or aggravates."

Again, he observes that the blood of all children is "superabundantly serous," but that it is redder in those of the second con-

stitution than in those of any of the others, and that this is more distinctly indicated by the color of the lips. "The quality of the blood," says he, "is necessary to dispose all the parts to elongate in their growth. When the proportions of the constituent elements of the blood are just, growth is accomplished without disease. If the proportions are otherwise than they should be for the preservation of the health, or if one or more of its elements be altered, health no longer exists, growth is arrested altogether or is performed irregularly. The nutritive matter is imperfect, assimilation is prevented or impaired. On the other hand, its disintegration decomposes the patient; if death does not sooner result it will consume him by the lesion of some vital organ."

The changes produced in the color of the blood by organic derangement are at once indicated by the color of the lips.

The accuracy of Laforgue's observations on the indications of the physical characteristics of the lips has been fully confirmed by subsequent writers.

"The secretion of the lips," says Prof. Schill, "has a similar diagnostic and prognostic import to that of the tongue and gums. They become dry in all fevers and in spasmodic paroxysms. A mucous white coating is a sign of irritation or inflammation of the intestinal canal; accordingly, this coating is found in mucous obstructions, in gastric and intermittent fevers, in mucous fever, and before a gouty paroxysm. A dry, brown coating of the lips is a sign of colliquation in consequence of typhus affections; it is accordingly observed in typhus, in putrid fever, in acute exanthemata, and inflammations which have become nervous."

The lips, however, do not present so great a variety of appearance as those of other parts of the mouth, for the reason that they are not as subject to local diseases; but their general pathological indications are, perhaps, quite as decided.

CHAPTER IX.

CHARACTERISTICS OF THE TONGUE.

THE appearance of the tongue, both in health and disease, is regarded by physicians as furnishing more correct indications of the state of the constitution and general health than any of the other parts of the mouth. It is asserted, however, by others, and by those too who have the very best opportunities for inspecting the various

parts of this cavity, that the lips and gums furnish as marked and reliable indications as the tongue. That the state and quality of the blood can be as readily ascertained by an examination of these parts as by that of the tongue, is, we believe, undeniable; but that the pathological condition of the body can be inferred is a question we leave for others to decide.

So far as the quality of the blood and the temperament of the subject are indicated by the color of the tongue, the preceding remarks concerning the lips will be found applicable, the one being as much influenced by them as the other. It will, therefore, be unnecessary to recapitulate what we have before said upon the subject.

The effects produced upon the mucous membrane of the tongue by disease in any other part are said to be analogous to those produced on the general integument. So, also, are the changes of its color, consistence, humidity and temperature, similar to those of the skin. We are likewise told that the changes of its coating agree with the analogous changes of the perspiration, and that these phenomena are more decided in acute than in chronic affections.

But the diagnostic and prognostic indications of the tongue vary according to the temperament and constitutional predisposition of the individual. The physician should acquaint himself with its appearances in health, to be able to determine correctly its indications in disease. He should likewise inform himself of the changes produced in its appearance by certain morbid conditions of the body. In some subjects it is always slightly furred and rather dry, especially near its root; in others it is always clean and humid; in some, again, it is always red, and in others pale.

Prof. Schill divides the signs of the tongue into objective and subjective. "To the objective belong the changes of size, form, consistence, color, temperature, secretion, and of power and direction of motion; and to the subjective belong the anomalous sensations of taste."

In enumerating the pathognomonic signs of the tongue, this author says that hypertrophy, inflammation or congestion, may occasion its enlargement; and that inflammatory swelling of it, when arising from acute diseases, such as "angina, pulmonary inflammation, measles, plague, or variola, yields an unfavorable prognosis. Even non-inflammatory swelling of the tongue is a dangerous phenemenon in acute diseases, especially cerebral, which are combined with coma. If it be the consequence of mercury, of the abuse of spirituous drinks, of gastric inflammation, of chlorosis, of syphilis, or if it occur in hysteria or epilepsy, the prognosis is not dangerous; but the disease is always the more tedious where the

tongue swells than where it does not. It is enlarged also by degenerescence and cancer.

"Diminution of the size of the tongue takes place where there is considerable emaciation. In this case it continues soft and movable. If, in acute states, the tongue becomes small, and is at the same time hard, retracted and pointed, the irritation is very great and the prognosis bad. This sign occurs more especially in typhus, in the oriental cholera, in inflammation of the lungs, and in acute cerebral affections. In hysteria and epilepsy this phenomenon has no unfavorable import."

Internal maladies, he says, seldom cause the form of the tongue to change; but that the simplest change arising from chronic irritations of the stomach, chronic dyspepsia, and acute exanthemata, is enlargement of its papillæ. In cases of protracted dyspepsia the edges of the tongue sometimes crack, and in paralysis and epilepsy it becomes elongated.

In acute diseases a soft tongue is a favorable indication; and flaccidity of it is symptomatic of debility.

Humidity of the tongue, he tells us, is a favorable sign, and that dryness of it occurs in acute or violent inflammations and irritations, and more particularly when seated in the intestinal canal and respiratory organs. "This also happens in diarrhœa, typhus, pneumonia, gangrene of the lung, pleuritis, peritonitis, enteritis, catarrhus gastricus, gastritis, inflammation of joints, etc. Among the higher degrees of dryness he enumerates the rough, the fissured and burnt tongue as furnishing still more unfavorable indications, informing us, at the same time, that if these be not accompanied by thirst, they prognosticate a fatal termination. The abatement and crisis of the disease is indicated by the tongue becoming moist."

Dr. Bell, of Philadelphia, in a note to Prof. Schill's observations on the tongue says, "A rough and dry, and even furred tongue is seen in some dyspeptic persons who sleep with the mouth open; and although it indicates an irritation of the digestive organs, it is not a bad augury." Bilious persons not unfrequently, though not troubled with any manifest symptoms of gastric or intestinal derangement, or any other apparent functional disturbance, have a furred tongue in the morning.

Paleness of the tongue, says Prof. Schill, is a sign of a serous condition of the blood, of chlorosis, of great loss of blood, of chronic disorders, of sinking of the strength, in acute maladies assuming a "nervous form, as typhus and scarlatina maligna. It is also found," says he, "in enteritis and dysentery, when but little fever is present." He infers from this that paleness of the tongue is caused by the

"drawing of the fluid downward;" but it is often observed in persons who enjoy tolerably good health. Lymphatic dispositions, as has been before remarked, are peculiarly subject to it.

Again he observes that a very red tongue is indicative of "violent inflammation, mostly of the intestinal canal, but also of the lungs and pharynx, also of acute exanthemata. He regards the prognosis as bad when a furred tongue, "in acute diseases of the intestinal canal, becomes clean and very red," if the change is not accompanied with the return of the patient's strength. "But," he continues, "if the debility is not considerable, and the tongue becomes clean and very red while other febrile symptoms continue, a new inflammation may be expected." But even in affections like these the redness of the tongue is always more considerable in sanguineous than in lymphatic or lymphatico-serous subjects, so that in forming a prognosis from this sign the temperament of the individual should never be overlooked."

Proceeding with the description of the signs of this organ, he says: "The tongue becomes a blackish-red and bluish-red in all serious disturbances of the circulation and respiration, as also in severe diseases of the lungs and heart, as catarrhs, suffocations, asthma, extensive inflammations of the lungs, carditis, Asiatic cholera, confluent smallpox and putrid fevers. It becomes black and livid in cases of vitiation of the blood, more especially in scurvy, at the setting in of gangrene, and in phthisis, when death is near at hand."

Among the diseases mentioned as giving rise to an increase of the temperature of the tongue are glossitis, violent internal inflammation, and typhus fever; and coldness of this organ is observed to take place in Asiatic cholera and at the approach of death.

The signs from the secretion of the tongue are thus enumerated: A clean and moist tongue are favorable indications, but a clean, dry and red tongue, as seen in slow, nervous fevers, acute exanthemata and plague, are bad auguries. A furred or coated tongue is said to occur chiefly in intestinal disorders, diseases of the lungs, skin, and in rheumatic affections. The coating is said to vary in "color, thickness, adherence, and extent," and different kinds of secretion from the mucous membrane of this organ are mentioned as occurring in different diseases, and it should have been added in the same disease in different temperaments.

After describing the various kinds of coating on the tongue, together with their respective indications, which it is not necessary here to enumerate, the occurrence of false membranes and pustules resulting from peculiar forms of mucous secretion, are next men-

tioned. The former show themselves either as small white points or large patches, and sometimes they are said to envelop the whole tongue. The color is "sometimes white, sometimes yellow, and sometimes red," and the greater the surface covered by them the more unfavorable is the prognosis regarded. "Pustules on the tongue," says our author, "are sometimes idiopathic, but in most cases symptomatic. They are either distinct or confluent; the confluent are the worst. Those which are hardish and dry, and also those which are blue, and those of a blackish appearance, which sometimes occur in acute diseases, are of an unfavorable import." On the other hand, those which have a whitish, soft, moist, and semi-transparent appearance, are less unfavorable, and when the aphthæ, or eruption, are repeated, it portends a longer continuance of the malady. The pustules or aphthæ are mentioned as being frequent accompaniments to the following diseases, namely: gastritis, catarrhs, enteritis, metritis, dysentery, cholera infantum, peritonitis, intermittent and typhus fevers, pleuritis, pneumonia, and the third stage of pulmonary consumption. Their prognosis is said to be favorable when they "appear with critical discharges after the seventh day," and unfavorable when they occur as a consequence of a general sinking of the physical powers of the body.

But it is unnecessary to enumerate all of the pathognomonic indications of the various morbid phenomena described by semeiologists; we have noticed more of them than was our intention to have done. We shall, therefore, conclude the present inquiry by simply observing that the indications furnished by the physical characteristics, not only of the tongue, but by those also of the teeth, the gums, salivary calculus, the lips, and fluids of the mouth, are, as we have endeavored to show, essential to the successful exercise of the duties both of the dental and medical practitioner.

CHAPTER X.

DISEASES OF THE DENTAL PULP.

THE pulp of a tooth, from the high degree of vitality with which it is endowed, is one of the most sensitive structures of the body, and, like other parts, is liable to become the seat of various morbid phenomena. Its susceptibility to morbid impressions is influenced by a variety of circumstances, such as temperament, habit of body, the state of the constitutional health, the condition of the hard structures

of the tooth, etc. A cause, which under some circumstances would not be productive of the slightest disturbance, might under others give rise to acute inflammation, with all its painful and disagreeable concomitants. Increased irritability (hyperæsthesia) may exist independently of any organic change, either in the pulp, dentine, or enamel. Examples are often met with in females during gestation; but it arises more frequently as a consequence of caries than from any other cause connected with the teeth. Even before the disease has penetrated to the central chamber of the organ the pulp often assumes a most wonderful and marked increase of irritability, either from functional disturbance arising from decomposition of the dentine, impaired relationship between the two, or from being more exposed to the action of external deleterious agents. Impaired digestion, as well as a disordered state of other functions of the body, frequently produces the same effect.

The susceptibility of the pulp to impressions of heat and cold and of acids is always increased by heightened irritability. When this exists to any considerable degree the mere contact of these agents with the tooth is often productive of severe pain, which on their removal very soon subsides. The pulp, however, may remain in this condition for months, and even years, without becoming the seat of inflammatory action.

Preternatural sensibility of the dentine, whether in a sound or partially decomposed state, augments very appreciably the irritability of the pulp. The sensibility of dentine is sometimes so much increased that the mere contact of any hard substance with a part which has become exposed by the destruction of a portion of the enamel is often productive of severe pain. Impressions of heat and cold conveyed through the conducting medium of a metallic filling, or through a thin covering of dentine, as sometimes happens when a considerable portion of the tooth has been worn away, is a very frequent cause of heightened irritability of the pulp. With its susceptibility thus increased, the impressions produced by these agents are often a source of irritation and even of inflammation and suppuration, causing the death of the entire crown and inner walls of the root of the tooth. At other times the irritation is only followed by slight increase of vascular action and an effusion of plastic lymph over the affected part of the pulp, which is gradually converted into *osteo-dentine*; and thus a barrier is interposed between it and the irritating agents.

Hyperæmia and Irritation.—The pulp of a tooth may become the seat of severe pain even when there is no inflammation. The slightest increase of vascular action, a condition known as *hyperæmia*, when

this organ is in a preternaturally irritable condition, is productive of more or less irritation. The pressure of even slightly distended vessels upon the nervous filaments distributed upon it, at such times, is sufficient to cause great pain.

Hyperæmia of the dental pulp may exist in any degree, according to the increased amount of blood which expands its vessels. The coronal portion of the pulp, what is generally known as its "bulb," exhibits the greatest distention under such conditions, and the pain resulting is often sharp and lancinating, and even paroxysmal in character. The pain from hyperæmia is often referred to other organs, such as the ear, face, and in fact to any part of the distribution of the fifth pair of nerves. Hyperæmia may result in diffuse inflammation of the pulp when the red blood-globules escape through the pulp-tissue, which generally occurs at the point where the distention is greatest. This condition is liable to occur in sound teeth as well as in carious ones. Within certain limits hyperæmia is a physiological condition, an impression induced by a temporary excitant, which soon passes away without injury to the parts involved. But when the cause is sufficient to bring about repeated attacks, the vessels of the pulp fail to contract, and remain distended with blood, and the affected organs become very susceptible to even slight thermal changes, and the hyperæmia becomes pathological instead of physiological. The treatment for hyperæmia of the dental pulp consists in the removal of the cause of irritation and the protection of the tooth from all thermal and other influences which may cause repeated distentions of its vessels with blood of more than the normal quantity. In the case of carious teeth the use of non-conducting filling-materials is indicated; in cases of otherwise healthy and sound teeth they should be protected from thermal changes until the susceptibility to such influences has passed away. Dr. G. V. Black recommends for the latter case a closely-fitting gutta-percha cap as a protection.

Impressions of heat and cold are conveyed more readily to the pulp when the dentine is in a morbidly sensitive condition, and when this is the case they produce a more powerful effect.

The remedial indications of pain in a tooth arising simply from irritation of the pulp, consist in the removal of the primary and exciting causes. When produced by impressions of heat and cold conveyed to it through the conducting medium of a metallic filling and intervening super-sensitive dentine, if the severity and continuance of pain is such as to warrant the belief that it will give rise to inflammation, the filling should be removed and some non-conducting substance placed in the bottom of the cavity before replacing it. If this is

done before inflammation actually takes place it will prevent subsequent irritation from these causes. It is worthy of remark, however, that the pain thus produced is in proportion to the sensibility of the subjacent dentine. If this is destroyed previously to filling the tooth, irritation of the pulp will be as effectually prevented as by the interposition of a non-conducting substance. But in the application of agents for this purpose there is danger of destroying the vitality of the pulp. The employment of them, however, is resorted to more frequently to prevent pain during the removal of caries than to relieve any subsequent irritation from impressions of heat and cold. (See Sensitiveness of Dentine.)

Although a frequent cause, yet a metallic filling is not the only medium through which impressions of heat and cold are conveyed to the dental pulp. When the dentine on the coronal extremity or side of a tooth becomes very thin from loss of substance occasioned by mechanical or chemical abrasion, by the use of the file, erosion, or other cause, the pulp sometimes becomes painfully susceptible to the action of these agents. Loss of substance from any of these causes is also often attended by exalted sensibility of the exposed dentine; and when this is the case the contact of acids with it is productive of more or less pain. Nature, however, usually prevents the painful consequences that would naturally arise from continued abrasion of the coronal ends of the teeth, and the consequent exposure of their nervous pulp, by the gradual ossification of this organ; so that by the time it would become exposed it is converted into osteo-dentine. But this does not always take place in time to prevent irritation and pain.

When irritation of the pulp occurs in a tooth that has been cut away on one or both sides, so much so as to leave only a thin covering of dentine, the best known means of preventing morbid sensibility is to keep the filed surface constantly clean by frequent friction with a brush and waxed floss silk, or with some other suitable substance. This operation should be repeated after each meal, and in the morning immediately after rising, and at night before going to bed. The application of nitrate of silver for sensitiveness arising from loss of substance or from exalted sensibility of exposed dentine, has proved successful. The nitrate in the solid form may be applied by enveloping a portion of the stick with wax, which will enable the operator to handle it with impunity. Or the end of a silver wire may be dipped in nitric acid and the application be thus made to the sensitive surface, taking care to protect the adjacent parts. Some are in the habit of applying salt as soon as the

sensitive surface has been touched with the nitrate, to neutralize its effects. To prevent contact with the gum, when it is necessary to apply the nitrate to the necks of the teeth, a coating of collodion may be painted on them with a camel's-hair brush. Chromic acid has also been used in these cases with success.

The careless use of the burr, and also of sand-paper disks, in the dental engine, may also induce irritation of the dental pulp on account of the heat generated by such agents.

When caries has extended to the central cavity, irritation is often produced by contact of partially decomposed portions of dentine or other foreign matter with the pulp. The proper remedial indication in such cases, it is scarcely necessary to say, consists in the removal of all matter from the teeth that can either act as a mechanical or chemical irritant. This done, the cavity in the tooth, supposing the pulp to be in a healthy condition, should be properly filled.

But when the irritation arises as a consequence of exalted irritability and increased vascular action of the pulp, dependent upon disease or altered function of some other part or parts of the body, the remedial indications are different. The treatment then should be addressed to the primary affection. Examples of this sort are of frequent occurrence. They are met with almost daily, particularly in females during gestation, in dyspeptic individuals, and in persons affected with gout and chronic rheumatism. They are also sometimes met with in individuals who have been exposed to miasmatic emanations of marshy districts, when the irritation assumes an intermittent form, occurring at stated intervals of twenty-four, forty-eight, or seventy-two hours, and continuing from one to three hours. Some of the worst forms of toothache are produced by one or other of these causes.

The local disturbance, when it occurs in females during pregnancy, may generally be removed by mild aperients, warm foot-bath, and anodynes at night on going to bed. When it depends upon other kinds of derangement of the uterine organs, treatment suited to the peculiar indications of the case should be instituted. When it occurs in a person affected with dyspepsia, rheumatism, or gout, the constitutional treatment required by the particular disease constitutes the proper remedy. When the irritation assumes an intermittent form, an emetic or cathartic, followed by quinine, will generally put a stop to the local disturbance, provided it has no connection with caries of the crown of the tooth.

INFLAMMATION—PULPITIS.

The pulp of a tooth, when healthy, has a grayish-white appearance, and its capillaries are invisible to the naked eye, but when it becomes the seat of *acute* or *active* inflammation, they may be distinctly seen, as the organ then assumes a bright red color. Inflammation, having established itself, soon extends to every part of the pulp, and even to the alveolo-dental periosteum. When permitted to run its course uninterruptedly, it usually terminates in suppuration in from three to eight or ten days.

The unyielding nature of the walls of the cavity in which it is on all sides inclosed renders expansion of the pulp impossible, and as its capillaries become distended with blood, they press on the nervous filaments which are everywhere distributed upon it, causing at first constant gnawing pain, which afterward, as the distention of the vessels increases, becomes severe, deep-seated, throbbing, and sometimes almost insupportable.

Inflammation may attack the pulps of sound teeth as well as those affected with caries; but it occurs more frequently in the latter than in the former, and it is oftener met with before than after the pulp has become actually exposed. The severity of the pain, however, is determined by the condition of the tooth, the state of the general health, and the causes concerned in its production. The pulp, when in an irritable condition, is more liable to become the seat of acute inflammation than when in a perfectly healthy state, and the occurrence of suppuration is soon followed by alveolar abscess, unless an opening is made immediately through the crown, neck, or root of the tooth, for the escape of the matter.

The effusion of lymph, which takes place during the inflammatory stage, and which, under other circumstances, and when the inflammation is less severe, is made to play an important part in the reparation of the injury, compresses the pulp into still narrower limits as it accumulates in quantity, and thus becomes an additional source of irritation, adding fuel to the flame already lighted up.

Inflammation of the pulp may be caused by a blow on the tooth; by impressions of heat and cold conveyed to it through the enamel and dentine, or through a metallic filling; or by the pressure of a filling, or the direct contact of external irritating agents, such as disorganized portions of the tooth, particles of alimentary substances, acrid humors, etc. But, as we have stated in another place, *inflammation* of the dental pulp is not always a necessary consequence of impressions of heat and cold; pain may be produced by them

when it does not exist; but in this case it usually subsides soon after the removal of the irritant. The exposure of the pulp by decay is a common cause of inflammation of the organ, also abrasion and the careless preparation of a cavity for the insertion of a filling, although in rare cases the pulp of a tooth may be exposed for months, and subjected several times a day to the actual contact of foreign bodies, without becoming the seat of acute inflammation. The irritation and increased vascular action thus occasioned are, no doubt, removed by the effusion of lymph to which they give rise, and the pulp, after it has become exposed, having room to expand as its vessels become distended, does not suffer irritation from the pressure to which it would otherwise be subjected.

Where suppuration takes place, the pain very nearly ceases, but the tooth for a time remains sore to the touch, and its appearance is changed. It has no longer the peculiar animated translucency of a living tooth, but has assumed an opaque, muddy or brownish aspect. With the disorganization of the pulp, the entire crown and inner walls of the root lose their vitality; still, if the alveolo-dental periosteum has not become seriously involved in disease, the vascular and nervous supply furnished to the cementum is often sufficient to prevent the tooth from exerting any injurious influence upon the surrounding and more highly vitalized parts. The cementum, being more analogous in structure to true osseous tissue than dentine, now plays an important part in the animal economy. It being more liberally supplied with vitality and with nutritive juices, and not being sensibly affected by the death of the other parts of the organ, it keeps up the living relationship of the tooth with the alveolo-dental periosteum, at least sufficiently to prevent it from acting perceptibly as a morbid irritant.

Inflammation of the pulp of a tooth, besides the local pain with which it is attended, often gives rise to a train of constitutional morbid phenomena, usually of a mild, but sometimes of an aggravated and even threatening character. Among these are *headache, constipation of the bowels, furred tongue, dryness of the skin, quick, full and hard pulse, earache, ophthalmia, disease of the maxillary sinus*, etc.

The amount of constitutional disturbance arising from inflammation of the pulp of a tooth depends on the state of the general health, and the nervous irritability of the system at the time. In the majority of cases it occasions but little inconvenience, and disappears as soon as the inflammation ceases, but sometimes it assumes a very alarming character. A fatal case of tetanus, produced by inflammation of the pulp of a lower molar, occurred a number of years ago in Baltimore. The subject was a young lady about eighteen years of age. The

system at the time, from great bodily fatigue and mental excitement, was in an exceedingly irritable condition, but in other respects, though constitutionally rather delicate, she was in the enjoyment of good health.

There is not an organ or tissue of the body in which acute inflammation is more intractable in its nature and rapid in its progress, than in the pulp of a tooth; and when we take into consideration its situation, and its physical and vital peculiarities, it is not to be wondered that it should, in so large a majority of the cases, terminate in the disorganization of the part. Still, it may sometimes be arrested, and the remedial indications here, though they cannot be as readily and fully carried out. are the same as for inflammation in any other part of the body. The first and most important one consists in the removal of all local and exciting causes. For simple exposure of the pulp, without sloughing, the first step, after removal of all irritants from the carious cavity, is to attempt the reduction of inflammation and the prevention of the effusion of serum or lymph, by cleansing the exposed surface with tepid water, and, after careful drying, to bathe it with dilute tincture of aconite, when it may be covered with a thin coating of a solution of gutta-percha in chloroform, or glycerine, or collodion carefully applied, and the tooth protected from irritation. Some prefer the use of a preparation composed of crystallized carbolic acid rendered fluid by a small quantity of chloroform. This preparatory treatment, if successful, is to be followed by the process of "capping the pulp," as described in another place. If it be the result of irritation produced by the pressure of a filling, the plug should be immediately removed, leeches applied to the gum of the affected tooth, and, if the patient be of a full habit, blood may be taken from the arm, and a brisk saline purgative prescribed. The removal of the filling, however, when the inflammation has previously made much progress, will not prevent suppuration, but it may keep it from extending to every part of the pulp. When an external opening is made for the escape of the matter, the moment suppuration takes place the remaining portion of the pulp will be relieved from the pressure which caused the irritation, and then the inflammatory action may cease. But if the mátter remains in the central cavity of the tooth, the part of the plug which has not suppurated will still be subjected to pressure, and the inflammation and suppuration will go on until the entire organ perishes. Nor will the disorganizing process stop here. The alveolo-dental membrane at the extremity of the root will soon become implicated, and in a short time alveolar abscess will form, thus terminating the acute stage of the disease.

There may be no indication of irritation or inflammation for several weeks, or even months, after a tooth has been filled; but at the expiration of this time the pulp, from increased irritability, caused perhaps by some change in the state of the patient's general health, may be attacked by inflammation. Although this very seldom happens, it does, nevertheless, sometimes occur. When there is reason to apprehend that it is about to take place—and it may be suspected if pain is felt in the tooth when anything hot or cold is taken into the mouth, or if it becomes the seat of gnawing or gradually increasing pain—the filling should be removed. If the pain now ceases, a thick layer of gutta-percha dissolved in chloroform, or Hill's stopping, or os-artificiel, or oxy-phosphate of zinc preparation, may be placed in the bottom of the cavity and the filling replaced; using the precaution, as before directed, to introduce the gold in such a way as to prevent the liability of depressing the floor of the cavity; or a temporary filling of some plastic, non-irritating substance, such as Hill's stopping or the oxyphosphate of zinc, may be inserted and permitted to remain for some time, when a more durable filling may be introduced. But if the pain and inflammation continue unabated, and the application of such escharotics as carbolic acid, chloride of zinc, nitrate of silver, and chromic acid, fails to reduce the congestion, it may be necessary to extract the tooth, or expose the pulp and destroy its vitality by applying to it some powerful escharotic. When this is done it is usually with the view of securing the retention and preservation of the tooth by filling the pulp-cavity and root, an operation now very frequently performed by dentists.

The abstraction of blood directly from the pulp, one might suppose would often be successful in arresting the inflammation; but we do not think this has been resorted to for this purpose sufficiently often to determine its therapeutic value. At any rate it seems reasonable to suppose that if by this means the congestion of the capillaries could be removed, the tumefied pulp would be reduced to its natural size, and be relieved from the pressure to which, as a consequence of its distended condition, it is subjected. To obtain the largest amount of benefit capable of being derived from the operation, the opening should be made in that portion where one of the principal arteries would be most likely to be punctured; and this, it seems to us, would be just where the canal of the root enters the chamber of the crown of the tooth. But in making the puncture here, the pulp being very small at this point, there is danger of cutting it off; and as reunion might not take place, the portion in the central cavity would necessarily perish.

If the pulp were exposed there would be a better opportunity of relieving the congested condition of its capillaries by the abstraction of blood; but the difficulty of obtaining free access to the organ by drilling a hole through the intervening dentine is very great; the tooth, when suffering from inflammation, being usually so sore to the touch that the slightest pressure is productive of great pain. Depletion of the pulp may be accomplished by means of a fine, sharp-pointed instrument; or Dr. Allport's method of treating exposed pulps may be resorted to, namely, that of excising a portion of the pulp at the orifice of exposure, and then drawing the edges together so as to induce union by first intention. If the tooth is an incisor or cuspid, and the pulp cannot be restored to health, its vitality should be destroyed; or, if suppuration has previously taken place an opening should be made into the chamber of the tooth as before directed, for the escape of the matter. Should it be found, after this has escaped, that disorganization has not extended to every part of the pulp the remaining portion may be destroyed in the manner hereafter to be described. This done, the pulp-cavity and root may be filled, as soon as the inflammation of the socket has completely subsided.

Dr. Black takes exception to the statement of C. A. Harris, Wedl, Tomes and Salter, that inflammation of the pulp is of frequent occurrence before the exposure of the organ, and he is of the opinion that the great mass of the cases occur coincidently with the exposure or afterward.

Chronic inflammation of the dental pulp often occurs where the chamber of a tooth has become gradually exposed by caries of the dentine; and when this happens the action of the fluids of the mouth, and of other foreign substances which obtain access to the cavity, as well as of the decomposed portions of the tooth-substance, causes an increase of vascular action in the exposed part, followed very often by a slight discharge; but the morbid action thus induced is comparatively seldom accompanied by pain. The pulp may remain thus partially exposed for months, and even years, without causing any other inconvenience than a momentary twinge of pain when some hard substance is accidentally introduced into the cavity of the tooth, which subsides immediately after its removal. Sooner or later, however, the pain thus excited will become more permanent, continuing each time it occurs, from five to ten minutes to one or more hours after the cause of the irritation has been removed. If a tooth be filled under such circumstances, the pressure of the fluid upon the pulp, which is poured out from its exposed surface beneath the filling, will give rise to a more general and active form of in-

flammatory action. Pain is often experienced before actual exposure of the pulp occurs.

The liability of the tooth to ache increases as the pulp becomes more and more exposed by the gradual decomposition of the dentine; and the inflammation may ultimately assume a more active form, when the pain becomes very acute, owing to the consequent effusion into tissue surrounded by unyielding walls, or the pulp may become the seat of fungous growth, or it may be absorbed or destroyed by ulceration, or by gangrene and mortification. Cases sometimes occur in which the disease is attended with severe darting pains, often occurring several times in the space of two or three minutes, succeeded by intervals of perfect ease for many hours. At other times it is attended by dull, aching pains, aggravated by taking sweet or acid substances into the mouth. In cases of this sort the application of heating or stimulating substances to the exposed surface of the pulp will usually procure relief. Permanent exemption from pain, however, is not always obtained, and sooner or later it may become necessary either to destroy the pulp or to extract the tooth. In some cases, however, where the pulp becomes exposed by the action of caries, no pain is experienced except by contact of foreign substances with the exposed surface.

The body of the pulp, when the organ becomes exposed from a decayed opening in the grinding surface of a molar, is sometimes absorbed, while its prolongations in the roots often remain unchanged for two or more years.

Exposure of the pulp is usually attended with *ulceration*—a disorganizing process, which often causes the destruction of a large portion of the part occupying the central chamber of the crown of the tooth, making in it numerous little excavations. The ulcerated surface usually presents a yellowish appearance, that of an irritable ulcer, with the exudation of a serous or sanguino-serous fluid, a condition, however, which must not be confounded with a state of suppuration. The exuded fluid is very offensive, as it rapidly decomposes, and its reaction is alkaline; when the disorganizing process is arrested before it has effected the destruction of any very large portion of the pulp, it usually becomes covered with healthy granulations.

When the inflammation occurs in cachectic individuals it often assumes an acute form, and sometimes terminates in gangrene and mortification. The loss of vitality may be confined to the body of the pulp, or it may extend to every part of the organ. In the former case the pain continues, but in the latter it ceases as soon as mortification takes place. When this happens, the entire pulp, which

has now a dark-brown or black color, may be removed. But this is not a very common termination.

The symptoms of chronic as well as acute inflammation are always modified by the state of the general health, habit of body, and the temperament of the individual. The pain attending the former, however, is periodical, occurring at irregular and uncertain intervals, and constitutes that variety of toothache so often relieved by local applications; whereas, in the latter, it is constant.

In chronic inflammation, which implies a state of ulceration, the pulp is either actually exposed or only covered by decomposed or partially decomposed dentine, and the diseased surface rarely embraces a larger circumference than that described by the bottom of the decayed cavity. The inflammation, therefore, is local as well as chronic, but, nevertheless, it is often of so persistent a character as to render its removal exceedingly difficult. The dentist, however, is not so much restricted in the application of remedies as in the treatment of acute inflammation, and to the action of which it yields more readily. But notwithstanding all this, he will necessarily encounter difficulties in his efforts to subdue it. A greater length of time is sometimes required than the patient is willing to give; and the opening through the crown to the central cavity is frequently too small, previously to the removal of the partially decomposed dentine, to admit of the direct application of the necessary remedial agent to the inflamed surface of the pulp. Again, it often happens that the situation of the tooth and cavity are such as to prevent a complete view of the diseased part. It is important that the operator should get such a view to enable him to determine whether the inflamed surface is ulcerated, or pours out a serous fluid; or whether the morbid condition is simply one of irritation, produced by the presence of acrid matter, or of partially or wholly decomposed dentine. Unless his diagnosis is correct, his prescription will be as likely to do harm as good; but, having ascertained the exact character of the disease, he may often be able to institute treatment that will result in the restoration of the pulp and the preservation of the tooth.

It is important, too, to understand the part which nature plays in the curative process; for cure here, as in other parts of the body, is effected by that internal force which, as Chomel says, "presides over all the phenomena of life, contends unremittingly with physical and chemical laws, receives the impressions of deleterious agents, reacts against them, and effects the resolution of disease." This vital force is sometimes exercised in the cure of disease in the pulp

of a tooth, but more frequently in its prevention; as is shown by the gradual ossification of the organ in those cases where it would otherwise become exposed by mechanical or spontaneous abrasion of the solid structures which enclose it; and occasionally by the formation of secondary dentine upon the surface of the original or primary dentine at a point toward which the caries is advancing. Nature, no doubt, would always provide in this way against the exposure of the pulp, if the occurrence were always long enough preceded by sufficient irritation or increase of vascular action in it to call her energies into operation. But the formation of osteo-dentine, which constitutes the protective wall of defence, is a tardy process, and, as a general rule, proceeds more slowly than the caries in the tooth, which causes the exposure of the pulp. Besides, it often happens that its approach is not announced by the slightest irritation, a condition necessary to the new formation, until it reaches the central cavity. At other times the approach of the disease gives rise to too much irritation, a condition equally unfavorable to the dentinification of the pulp. Thus, no protective covering being formed, it soon becomes exposed, when it is subjected to the action of such irritating agents as may chance to be brought into contact with it. Hence its liability to become the seat of chronic inflammation as well as other forms of diseased action.

If the disease is attended with pain, the removal of this must first claim attention, and should be effected with as little delay as possible; otherwise the morbid action may extend to every part of the pulp and peridental membrane and assume a more active and unmanageable form. If the pain is the result of irritation produced by the direct action of mechanical or chemical agents, the cavity in the tooth should at once be carefully freed from all extraneous substances and decomposed portions of dentine. This done, a dossil of raw cotton or lint—saturated with spirits of camphor, laudanum, sulphuric ether, chloroform, creasote, or some one of the essential oils—may be applied. The following anodyne application has been employed with advantage to relieve the pain arising from congestion of the pulp: Cotton saturated with a solution composed of alcohol, 1 ounce; chloroform, 2 ounces; ether, $\frac{3}{4}$ ounce; gum camphor, $\frac{1}{2}$ ounce; tincture of opium, $\frac{1}{2}$ ounce; and oil of cloves, 1 drachm. When the pain is relieved another application, consisting of carbolic acid and oil of cloves, is made and permitted to remain for some fifteen minutes. A paste composed of iodoform and glycerine is also employed after the active symptoms of congestion have subsided.

For the treatment of wounded and irritated pulps the tincture of

calendula proves a very useful remedy. Such agents as glycerole of thymol, carvacrol, oil of eucalyptus, tannic acid, lead water, morphine, creasote, chloral, and tincture of aconite have also been found serviceable in the treatment of inflamed conditions of the pulp.

When the irritation is produced by acidulated buccal fluids, the application of carbonate of soda, or some other alkali—tepid water containing sufficient carbonate of soda to make it slightly alkaline—will often give immediate temporary relief; but as the condition of the secretions of the mouth, especially the salivary, is usually owing to gastric derangement, the correction of this constitutes the first and most important remedial indication. When any application is made to the pulp for the purpose of removing irritation and pain, its full effect will not be obtained unless the fluids of the mouth are excluded from the cavity of the tooth; this may be done by closing the orifice with softened wax, or cotton saturated with the sandarach solution, using the precaution not to force it so far as to press the application previously made upon the exposed pulp.

Suppuration of the Pulp.—Independent of the condition known as alveolar abscess, the pulp of a tooth is liable to suppuration when exposed for a considerable time, by the formation of either an abscess within its substance, or, more frequently, by a superficial suppuration on its surface.

In such cases, layer after layer of the substance of the organ is destroyed at the point of exposure, and inflammatory elements or products take their places. The layer of odontoblasts is disorganized as a result of superficial inflammation, and becomes a mass of sanious pus filled with micro-organisms. Deep pockets are formed in the substance of the pulp by the suppurative process, and a section of the organ is progressively destroyed from the exposed surface in the direction of the root. This progressive suppuration and destruction may continue until a small portion only remains in the apical portion of the root-canal, or the entire organ is destroyed. Many histologists are disposed to question the theory that the dental pulp ever recovers after suppuration is once established in it, while some contend that cicatrization and ability to perform its functions are possible after such attacks.

Suppuration of the pulp generally commences in the form of small collections of pus within the layer of odontoblasts which may retain their distinct forms for some time, when they may coalesce. Deeper in the structure of the pulp a large abscess may undermine the layer of odontoblasts, and if the pus generated under such cir-

cumstances is greater in quantity than the cavity for its retention, compression and strangulation of the pulp result, causing the destruction of the organ. The pain accompanying abscess of the pulp generally commences with a slight gnawing sensation, which persistently increases in severity until it becomes very excruciating. When decomposition of the entire pulp occurs, gas is generated, which, by its pressure, gives rise to severe pain, and the trouble is only relieved by a vent being made for the escape of the gas and secretion. It is seldom, however, that gas is formed within the living pulp, although there are cases sometimes met with where gas is generated in a closed pulp-cavity during the progress of the suppuration in the pulp. A small amount of pus in a pulp chamber may undergo absorption, or even fatty degeneration, but such cases are rare.

The causes of suppurative pulps may be enumerated as follows: Mechanical violence, such as blows; the careless regulating of teeth; the rapid separation of teeth by wedges, screws, etc., or separation by any method when the condition of the system contraindicates such an operation; thermal influence through a metallic filling, and especially in the case of young teeth; exposure of the pulp to irritating agents. A dead pulp may remain quiet for months, or even years, and if not exposed by caries, even for many years, but the action of the atmosphere may in a very short time cause inflammation of the peridental membrane; hence it is often a question whether teeth in which dead pulps are quiescent should be interfered with. But as all such teeth are liable to cause periodontitis and alveolar abscess the treatment of such cases, where no exposure exists, is to make an opening with a drill into the pulp-chamber, the entrance of the instrument being easily recognized by its sudden opening into such a space.

When this is effected, an antiseptic agent, such as oil of eucalyptus, iodoform in the form of an ethereal saturated solution, or permanganate of potash, should be introduced into the pulp-cavity, taking care to leave a vent through the temporary filling which is to confine the antiseptic agent. The remains of the devitalized pulp should be removed at a second sitting by means of a barbed broach, and a second application of the antiseptic made. Such treatment should be continued until all odor of decomposition has disappeared, and the cavity will permit of being closed tightly without trouble ensuing. The antiseptic agent must be thoroughly applied, so that it may pass into every part of the pulp-cavity and the dentinal tubes. It should be remembered that the product of

decomposition, which is principally sulphuretted hydrogen exhibited in the form of gas, is not only rapidly developed, but exerts great pressure in the apical space; hence the roots of a tooth thus affected should not be filled until there is every reason for believing that the decomposition has been overcome. It may be necessary in these cases to continue the antiseptic treatment for several weeks before filling the pulp-cavity, although immediate root-filling, even in such cases, has its advocates.

Degeneration of Structure.—This condition may result from a low degree of inflammation of the pulp when long continued, which has the effect of so reducing its volume that it presents a shriveled appearance, and to which the term "mummified" has been applied.

The pulp-cavity in such cases is entirely free from any products of decomposition, and the tooth retains its natural color. This affection appears to be more common to teeth of a dense structure, and has been ascribed by writers on this subject to a gradual obliteration of the tubuli by a deposit of secondary dentine, which interferes with nutrition to such a degree as to produce attenuation. The original cells of the tissue disappear and are changed into fine fibres, and areolæ are developed in the matrix, and the sensibility of the pulp is either greatly diminished or altogether destroyed, the latter being the condition of completely mummified pulps. Dental pulps in such a condition never become a source of irritation, and the only treatment required is the removal of the remains of the attenuated organ and the filling of the pulp-cavity.

Spontaneous Disorganization.—The spontaneous destruction of the pulp of a tooth is an affection which seems to have been for a long time overlooked by writers on dental pathology; and, although it is one which rarely occurs, examples of it are met with sufficiently often to entitle it to a place among the diseases of the teeth. The first case which attracted the attention of the author occurred in 1836, and he has subsequently met with six or seven others. In each of them the disorganization had been carried on so insidiously that neither the presence of disease nor structural alteration was suspected until the teeth assumed a dull brownish or bluish-brown appearance. The death of the pulp had not been preceded in any of these cases by the slightest indication of inflammatory action. It had apparently resulted from want of sufficient vital energy to sustain the nutritive function.

The alveolar cavities of the affected teeth in these cases were, seemingly, in a healthy condition—a circumstance which, when we take into consideration that the parts of the extremity of the roots

were exposed to the action of the disorganized remains of the dental pulps, may appear somewhat strange. But this may have been owing, partly, to diminished excitability in the alveolo-dental periosteum, and partly to the smallness of the quantity, and the innocuous character of the matter contained in the central cavities of the teeth. The gums of that portion of the alveolar border occupied by the affected teeth had a pale, grayish-purple appearance, but exhibited no indications of actual disease. They were as thin and their margins as distinctly festooned here as in any other part of the mouth. In some instances, the teeth had been in this condition for seven or eight years. On perforating the crowns, only a drop of dark-brown matter, about the consistence of thin cream, and having but little odor, escaped from the pulp cavity of each.

In all the cases which the author has seen of this remarkable affection, the loss of vitality had taken place previously to the twentieth year of age, and, according to his observations upon the subject, it seldom confines itself to a single tooth, but occurs simultaneously in corresponding teeth. The pulps of several usually perish at about the same time. In the first case to which his attention was called, six had lost their vitality. The affection, too, seems to be principally confined to the incisors and cuspids, and sound teeth appear to be as subject to it as those which are carious.

Now, as the disorganization of the pulp, in cases of this sort, is not the result of inflammatory action, it must be dependent upon constitutional rather than local causes—upon some peculiar cachexia, which causes the function of sanguinification to be imperfectly performed. This inference, too, seems to be fully warranted by the appearance of the subjects in all the cases which the author has had an opportunity of examining—characterized by an extremely pale and slightly bloated aspect of countenance, indicating a serous condition of blood.

The remedial indications in cases of this sort are the same as in necrosis produced by inflammation and suppuration of the lining membrane and pulp.

Fungous Growth.—The pulp of a tooth, when exposed by decay of the crown, sometimes becomes the seat of a fungous growth, in the form of a small vascular tumor, the formation of which is caused by constant irritation. These morbid growths sometimes attain the size of a large pea, completely filling the cavity made in the crown of the tooth by decay; at other times they do not exceed that of a small elderberry. The former have little sensibility, and bleed freely from the slightest injury; the latter are less vascular, but are nearly as sensitive as the pulp in a healthy state.

It often happens that a fungous growth of the gum or dental periosteum, finding its way through an opening in the side of the neck or root of a decayed tooth, appears in the central cavity, and is sometimes mistaken for a morbid growth of the pulp. But the character of a fungous growth or polypus of the pulp can be readily determined by its attachment to the portion of the organ occupying the pulp-chamber by a constricted neck. Such fungous growths have a dark-red color and a fleshy or spongy consistence. Such fungous growths are more common to the pulps of the inferior molar teeth when caries has hollowed out the crowns to a considerable degree. Such tumors usually grow very fast, and sometimes attain the size of a hickory nut. They are exceedingly vascular, bleeding profusely when wounded, and are soon reproduced after removal. The author has met with tumors of this kind which had originated in the alveolo-dental periosteum of the extremity of the root.

The only remedy in many cases of fungous growth of the pulp is the removal of the tooth. A cure cannot be effected by extirpating the morbid growth. The author has frequently removed them nearly to the extremity of the root, but they have always reappeared in a few days or weeks after the operation. A pulp in this condition resists the action of arsenious acid when applied for its devitalization.

Where there is a tendency to fungous growth of the pulp, the application of an escharotic has proved serviceable. Of these agents chromic acid appears to be very effective.

Another method is to apply carbolic acid freely to the fungous growth, to obtund its sensitiveness, excise it, and then make an application of nitric acid on a disk of card-board. A method of treating such fungous growth is described by Dr. Maercklein, as follows: After carefully removing all foreign substances and carefully drying the cavity, apply the tincture of iodine with a pledget of absorbent cotton or bibulous paper until the entire growth is covered with the iodine; after which seal the cavity in the usual manner. This should be repeated every twenty-four hours until it has been completely destroyed. If the fungous growth should fill the entire cavity, take small pledgets of the paper or cotton saturated with the iodine and place them between the fungoid and the walls of the cavity until as much pressure has been made as is consistent with the comfort of the patient, but in no case giving pain. This dressing is repeated daily until sufficient room has been obtained to proceed as in the first case. It frequently happens, however, that teeth in this condition are too far gone to justify their retention.

Ossification.—Allusion has been made several times, in the course of this work, to the ossification of the dental pulp, as a means employed by nature to prevent the exposure of this most delicate and exquisitely sensitive structure. But examples of it are occasionally met with in teeth which have suffered no loss of substance, either from mechanical or spontaneous abrasion, or from the decay of the dentine. The occurrence, whatever may be the circumstances under which it takes place, is evidently the result of the operation of an established law of the economy, dependent upon moderate irritation and a slight increase of vascular action; ossification having commenced, it usually goes on until every part of the pulp is converted into a substance analogous to cementum. We infer, then, that when the pulp of a tooth becomes the seat of a sufficient amount of irritation, ossification must follow as a necessary consequence; but if the irritation be succeeded by active inflammation, a different result may be expected.

The irritation necessary for the ossification of the pulp of a tooth sometimes arises from constitutional causes; but in the majority of cases, it results from the action of local irritants, and most frequently from impressions of heat and cold, communicated through the medium of a metallic filling or a thin layer of dentine.

During the ossification, a sensation is occasionally experienced in the tooth somewhat similar, though altogether less in degree, to that which attends the knitting of the fractured extremities of a broken bone. A numb, vibratory pain, barely perceptible, is first felt passing through the tooth several times a day, but only lasting a second or two at a time. It is often scarcely sufficient to occasion any annoyance, or to attract anything more than momentary attention.

As the ossified deposit increases in size, pain of a neuralgic character may ensue, and similar to the sensation which results from the knitting together of the fractured extremities of a bone, but not constantly severe. At times, however, the pain becomes sharp and darting, affecting the side of the face and head. The treatment consists in the application of an anodyne, such as lead water, about the affected root and the opening of the pulp-chamber, in order to remove the affected pulp, which should be completely extirpated.

With the ossification of the pulp, the crown and inner walls of the root lose their vitality, but the appearance of the tooth is not, as in the case of necrosis arising from the disorganization of the pulp, materially affected. The central cavity being filled with semi-translucent osteo-dentine, the crown retains its natural color.

The discoloration and opacity attending necrosis produced by other causes result partly from the presence of putrid matter in the pulp-cavity, and partly from its absorption by the surrounding dentinal wall.

Odontalgia.—Pain in a tooth, toothache, or *odontalgia*,* as it is technically termed, is a symptom of some functional or structural disturbance, either of the organ in which the pain is seated, or of some other part or parts of the body, but more frequently of the former than of the latter. So variable is the character of the sensation, that any description would fail to convey to one who has never experienced it a correct idea of its nature. The pain sometimes amounts only to slight uneasiness; at other times the agony is almost insupportable. It may be dull, deep-seated, boring, throbbing, or lancinating. It may be slight at first, gradually increasing in severity until it amounts to the most excruciating torture, or it may come on without any premonition whatever. It may be confined to a single tooth, or it may affect several at the same time. It may commence in one tooth and pass from thence to another, and continue until every one in turn has been attacked. It may continue for hours and days with scarcely any cessation; or it may be intermittent, the paroxysms recurring at stated or irregular intervals, and each lasting from thirty minutes to one, two or more hours.

The causes of odontalgia are almost as numerous as are the varieties of character which it exhibits. Irritation and inflammation of the pulp, and inflammation of the investing membrane, are among the most frequent; but it is sometimes referable to a morbid condition of the nerve or nerves going to a single tooth, or of the trunk from which several teeth are supplied; also to derangement of the digestive organs, to increased nervous susceptibility of the uterus resulting from pregnancy, amenorrhœa, etc., and to certain diatheses of the general system.

Inflammation of the peridental membrane and pulp may be produced by a blow upon a tooth, or by powerful impressions of heat and cold communicated through the enamel and dentine, or through a metallic filling; but it is more frequently occasioned by pressure, or by the direct contact of irritating agents, such as carious portions of the tooth, particles of food, acrid humors, and other irritating

* So much has been said upon this subject in the consideration of the different forms of inflammation of the pulp in the preceding pages, that but little remains to be noticed.

external substances. But inflammation is not always a necessary consequence of such impressions. Pain may be produced by them when inflammation does not exist; in this case it usually subsides soon after the removal of the irritant. Indeed, the pulp of a tooth may be exposed for months, and subjected several times every day to the contact of foreign substances, without becoming the seat of inflammatory action; and in the absence of this, the pain, though coming on with the suddenness of an electric flash, and often of the most excruciating kind, is seldom of long duration.

But when inflammation exists, the pain, which at first amounts only to a slight gnawing sensation, is more constant; after a while it assumes a throbbing character, and if not promptly arrested it increases in severity and continues until suppuration of the lining membrane and pulp takes place. So long as it is confined to the parts within the pulp-cavity the pain is not increased by pressure on the tooth, nor is the tooth started from the socket, as in periodontitis. The locality of the inflammation may also be distinguished by the fact that cold water or ice applied to the tooth generally gives relief. But the inflammation rarely confines itself long to the interior of the tooth; it usually soon extends to the periosteum of the root and its socket, when a somewhat different train of phenomena are developed. Suppuration, however, having taken place, an abscess soon forms at the extremity of the root.

The severity of the pain attending *pulpitis* (as inflammation of the pulp is technically termed), is doubtless owing to the fact that this exceedingly sensitive structure, as its vessels become injected, is prevented from expanding by the unyielding nature of the walls of the cavity in which it is situated. Its capillaries being thus distended, must, as a necessary consequence, press upon the nerves which are everywhere distributed through it, and the excruciating painful, throbbing sensation, by which this variety of odontalgia is characterized, is produced by the pulsation of these vessels. Hence, increased action of the heart and arteries, from whatever cause produced, augments the pain; it is also more severe at night, while the body is in a recumbent posture, than during the day, because this position gives an increased fullness to the arteries of the head. The phenomena attending the inflammation, however, are influenced very much by the condition of the tooth and the habit of body of the patient.

When the inflammation is acute, it extends to every part of the pulp and lining membrane. It also occurs more frequently before than after these tissues have become exposed, and generally terminates in suppuration. Chronic inflammation usually arises from

partial exposure of the pulp, and may exist for months without being attended with pain; but the pulp, when thus affected, is more susceptible to injury by heat or cold and by irritating substances; and the liability of the tooth to ache, especially at night, is greatly increased.

Odontalgia, caused by acute inflammation of the investing membrane, is characterized by pain, at first dull, afterward acute and throbbing, soreness and elongation of the tooth, redness and tumefaction of the gums, and sometimes by swelling of the cheek; indicating the formation of alveolar abscess. In this variety of odontalgia the tooth is often so much raised in its socket as to interfere more or less with mastication.

The pain attending the foregoing pathological conditions, when severe and protracted, is often accompanied by constipation, headache, dryness of the skin, flushed cheeks, fullness and increased rapidity of pulse, and other constitutional symptoms.

The nervous susceptibility of the teeth is sometimes so much increased by organic and even functional disturbances of other and often remote parts, that the mere contact of the minute nerves of the pulp and the lining membrane against the wall of dentine which encases them is attended with severe pain. This variety of odontalgia is termed *sympathetic*, and is supposed to be the result of the transfer of nervous irritation, or more properly, of *exalted sensibility* of the dental nerves, arising from a morbid condition or functional disturbance of some other part. If this hypothesis be true, it is probable that with this heightened nervous excitability there is a slight increase of vascular action in the pulp, with a corresponding increase of size in its capillaries; in consequence of which, it is fair to presume the nervous filaments supplying these tissues would be apt to respond painfully to the undue pressure. Though pain arising from this cause may have its seat in sound as well as in decayed teeth, it occurs more frequently in the latter than the former, owing to the fact that any structural alteration in the dentine adds to their already increased nervous excitability.

Persons of highly excitable nervous temperaments, pregnant females, and individuals laboring under derangement of the digestive organs, are particularly subject to this variety of odontalgia. Odontalgia arising from pathological conditions or functional disturbances of other parts, assumes a great variety of forms. The pain may be continued, but more frequently it is periodical; it may be confined to a single tooth, or it may attack half a dozen or more at the same time. It sometimes also alternates with the paroxysms of rheumatism or gout, the pain in such cases assuming the specific character of these diseases.

Mr. W., aged forty, for fifteen years the victim of gout, came to me in 1830. The first right upper molar was carious, but the pulp not exposed. Ten or twelve days before each attack of gout, recurring every three or six months during the last five years, this tooth was the seat of a peculiar grinding, lancinating pain, becoming gradually more severe, but ceasing entirely as the gout-symptoms came on; it returned as these subsided, and continued for two weeks. Filling the tooth gave temporary relief only, and it was found necessary to extract it.

In what is termed neuralgic odontalgia, "the pain," says Dr. Wood, "is usually of the acute character; sometimes mild in the beginning, gradually increasing in intensity, and as gradually declining, but usually very irregular; at one time moderate, at another severe, and occasionally darting with excruciating violence through the dental arches. Not unfrequently it assumes a regular intermittent form. Instead of pain, strictly speaking, the sensation is sometimes of that kind which is indicated when we say that the teeth are on edge, and is apt to be excited by certain harsh sounds, such as that produced in the filing of a saw, or by mental inquietude, and by the contact of acids or other irritant substances. Neuralgic toothache sometimes persists, with intervals of exemption, for a great length of time. The diagnosis is occasionally difficult. When, however, it occurs in sound teeth, is paroxysmal in its character, is attended with little or no swelling of the external parts, occupies a considerable portion of the jaw, and especially when it alternates or is associated with pain of the same character in other parts of the face, there can be little doubt as to its real nature." This variety of sympathetic toothache is perhaps induced by caries, or by the manner in which the teeth are arranged in the alveolar arch, or by some peculiar susceptibility of the parts; as is shown by the fact that the pain usually ceases on the removal of all such causes of irritation.

But while, on the one hand, pain in the teeth may be caused by a morbid condition of other organs, these organs, on the other hand, frequently sympathize with the diseased condition of the teeth, and become, to quote the language of Mr. Bell, "the apparent seat of pain. I have seen this occur not only in the face, over the scalp, in the ear, and underneath the lower jaw, but down the neck, over the shoulder, and along the whole length of the arm." Cases of this sort are frequently met with.

In treating of odontalgia, Dr. Good observes: "This is often an idiopathic affection, dependent upon a peculiar irritability (from a cause we cannot easily trace) of the nerves subservient to the aching tooth, or of the tunics by which it is covered, or of the periosteum,

or the fine membrane that lines the interior of the alveoli. But it is more frequently a disease of sympathy, produced by pregnancy, or chronic rheumatism, or acrimony in the stomach, in persons of an irritable habit. It is still less to be wondered at that the nerves of the teeth should often associate in the maddening pain of facial neuralgia, or tic douloureux, as the French writers sometimes term it; for here the connection is both direct and immediate. In consequence of this, the patient, in most instances, regards the teeth themselves as the salient points of pain (as they unquestionably may be in some cases), and rests his only hope of relief upon extraction; but when he applies to the operator he is at a loss to fix upon any particular tooth. Mr. Fox gives a striking example of this in a person from whom he extracted a tooth, which afforded little or no relief; in consequence of which his patient applied to him only two days afterward and requested the removal of several adjoining teeth, which were perfectly sound. This he objected to, and, suspecting the real nature of the disease, he immediately took him to Sir Astley Cooper, who, by dividing the affected nerve, produced a radical cure in a few days." The author is acquainted with a gentleman similarly affected. He has had all his teeth on the right side of both jaws extracted without obtaining any relief.

There is still another cause of odontalgia which we should not omit to mention—exostosis; but from the obscurity of the diagnosis, the existence of the affection can seldom be determined with positive certainty, except by the removal of the tooth. As we have already had occasion to treat of this disease, it is unnecessary in this place to dwell upon the subject.

Finally, some teeth, from peculiar constitutional idiosyncrasy, are more liable to odontalgia than others. It sometimes happens that every tooth in the mouth is destroyed by caries without being affected with pain, while at other times teeth apparently sound become the seat of the most agonizing torture.

The first thing to be attended to in the treatment of odontalgia is the removal of the causes which have given rise to it; this can only be done by carrying out the curative and remedial indications of the morbid conditions and functional disturbances with which it is connected. While these continue, it will be impossible to obtain permanent relief. The sensibility of the nerves supplying a tooth may often be obtunded and the pain palliated by the application of stimulating and anodyne agents to the exposed pulp, but the relief thus procured is seldom of long duration. When their effects subside, the pain usually returns with increased severity. When the pain arises from chronic inflammation and irritation, produced by external agents on an exposed portion of the lining membrane

such applications may often be employed with great advantage; and among those which have been used for this purpose are creosote, the oil of cloves, cinnamon, etc., laudanum, spirits of camphor, tannin, ether, and chloroform. But of all the remedies prescribed by the author he has found none more useful in allaying the pain than the following:—

℞. Sulphuric ether,	℥j.	℞. Sulphuric ether,	℥j.
Powdered camphor,	ʒij.	Creosote,	ʒss.
Powdered alum,	ʒij.	Ext. of nutgalls,	ʒj.
Sulphate of morphine,	gr. ij.	Powdered camph.,	ʒss.

The alum should be very finely powdered, and all the ingredients well mixed before use.

℞. Chloroform,		℞. Chloral,		
Tinct. opii, āā	ʒij.	Camphor, āā	ʒj.	
Tinct. benzoin,	ʒviij. M.	Morphine,	gr. ij.	
		Oil of peppermint,	ʒij.	M.

After removing all foreign matter and carefully drying the cavity of the tooth, a small bit of cotton or lint dipped in either of the above mixtures may be applied, and renewed several times a day, if necessary. The relief obtained is, in the majority of cases, almost instantaneous; but as the effect is only temporary, the pain is apt to recur. The author has sometimes used a thick solution of gutta-percha in chloroform. The application of a drop or two of this to the exposed pulp is usually followed by the immediate cessation of pain, and as the chloroform evaporates, a thin layer of gutta-percha remains, and serves for a time as a sort of protection to the pulp.

It often becomes necessary to have recourse to the destruction of the pulp, as there are many cases in which the patient cannot be prevailed upon to submit to the former, and as there are others in which the retention of the organ is called for by some peculiar necessity. This may be effected either by immediate extirpation with a small, sharp-pointed elastic stilet or probe, by the actual cautery, arsenious acid, carbolic acid, cobalt, or chloride of zinc. Immediate extirpation, or the application of devitalizing agents, are the means usually employed for the purpose.

Pain in a tooth arising from acute inflammation of the pulp and lining membrane can only be relieved by the extraction of the tooth, the destruction of the pulp, or by subduing the inflammatory action; the last can seldom be done except by the most energetic treatment in the very beginning, in cases where the decay has not penetrated to the pulp cavity. The propriety or impropriety of extraction will be determined by the amount of pain, the progress made by the inflammation, the condition of the parts with which the tooth is immediately connected, the effect of local disturbance

upon the general system, the situation and importance of the tooth, and the extent of structural alteration which has taken place in the crown. If the retention of the tooth, on account of its location, or the loss of several other teeth, is of great importance to the patient, and the circumstances of the case justify a well-grounded belief that it can be preserved and rendered useful without acting as a morbid irritant, the operation, if possible, should be avoided. In this case, supposing the inflammation to have proceeded too far to be arrested, the pulp may be destroyed and the tooth treated in the manner described in another chapter.

When the inflammation is produced by other causes than exposure of the pulp and the contact of external irritants, it may perhaps be successfully combated. The treatment is similar to that for local inflammation in other parts of the body; the administration of saline cathartics, the application of leeches to the gum of the affected tooth, abstinence from animal food and stimulating drinks. If the pulse is full and hard, blood may be taken from the arm with advantage. Diaphoretics are often beneficial, such as Dover's Powder or Spirit of Mindererus. Bromide of potassium, in doses of gr. v to gr. xl, with a mustard plaster to the back of the neck and a hot foot-bath, will also be found efficacious. Should these means fail to arrest the inflammation, and suppuration take place, the formation of alveolar abscess may be prevented by promptly perforating the crown of the tooth for the escape of the matter; but such cases usually terminate in periodontitis, which perhaps arises as frequently from this as from any other cause.

As the treatment of periodontitis or inflammation of the investing membrane is described in another chapter, it is unnecessary to repeat it. But when the formation of alveolar abscess is threatened the removal of the tooth, in many cases, will be found necessary. If it be an incisor or cuspid, however, the operation should be performed as a last resort.

Odontalgia, assuming a rheumatic or gouty character, calls for a somewhat different plan of treatment. In addition to the local means already described, it may be necessary to adopt the constitutional treatment applicable to rheumatism and gout. When the pain arises from increased vascular action and nervous irritation of the pulp, occasioned by a disordered condition of the digestive organs, and assumes an intermittent form, an emetic or cathartic, followed by the use of quinine, will generally afford relief, provided caries has not penetrated to the pulp cavity. If dependent on general nervous irritability of the system, tonics, exercise, change of air, or such other constitutional measures as the peculiarities of the case may indicate, should be recommended.

The extraction of the tooth is the only remedy that can be relied upon for relief of pain arising from exostosis of the root. Dr. Good, however, thinks it may be cured in the early stages by the use of leeches and mercurial ointment, and others recommend the internal use of iodide of potassium.

DEVITALIZATION AND REMOVAL OF THE PULP.

With regard to the best means of destroying the pulp of the tooth, when it is impossible to preserve it, there exists much diversity of opinion. There are two methods by which this may be accomplished, one by immediate *extirpation* with an instrument and by *actual cautery,* the other by the application of some devitalizing agent, as *arsenic.* Each method has its advocates.

For the removal of the pulp by extirpation there are different forms of instruments employed, such as a three- or four-sided broach, barbed for some distance from the point, which is thrust as far up the pulp canal as is possible, then rotated and withdrawn, bringing the pulp with it. Fig. 123 represents a broach of this kind, which may be used with or without a holder. Another form of broach is used for this operation which is not barbed, but thrust into the pulp for the purpose of so lacerating it that it may afterwards be removed with nerve instruments without much pain. A fine, round, steel wire, from which the temper has been drawn, and having a flat point bent on an angle of about forty degrees, is also used for extirpating the pulp.

The edge of the point, in introducing this instrument, is pressed against one wall of the canal and gradually forced up as far as it will enter, when it is suddenly turned so as to excise the pulp and on withdrawing the instrument bring the severed organ with it.

Figs. 124 and 125 represent excellent forms of instruments devised by Dr. R. B. Donaldson for cleansing pulp-canals and removing pulp.

For extirpating the pulps of the molar teeth a larger instrument is required, which is thrust into the pulp-chamber and rotated so as to sever the body of the pulp from the branches filling the root canals. The small nerve instruments are then employed for removing these branches.

The operation of extirpation should depend upon the temperament of the patient and the condition and class of the tooth. Where such an operation would cause a severe shock, owing to a nervous, irritable temperament, it is best to employ the therapeutical method; on the other hand, where there is great power of endurance, and the tooth is of a frail, chalky consistence, or threatened with periosteal inflammation, it is preferable to remove the pulp by

an operation. The pain, however, can be greatly mitigated by the previous application of some obtunding agent, such as sulphate of atropine, aconite, cocaine, or chloroform.

FIG 123.

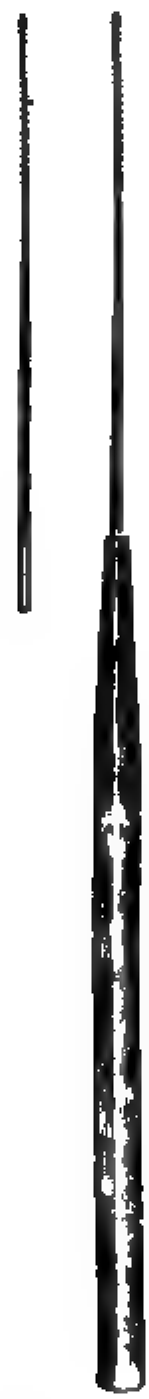


FIG. 124.

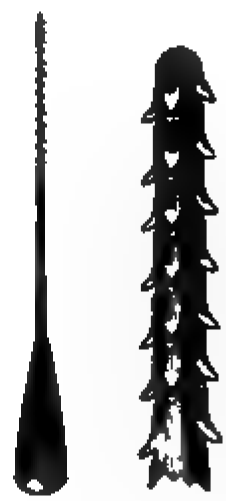
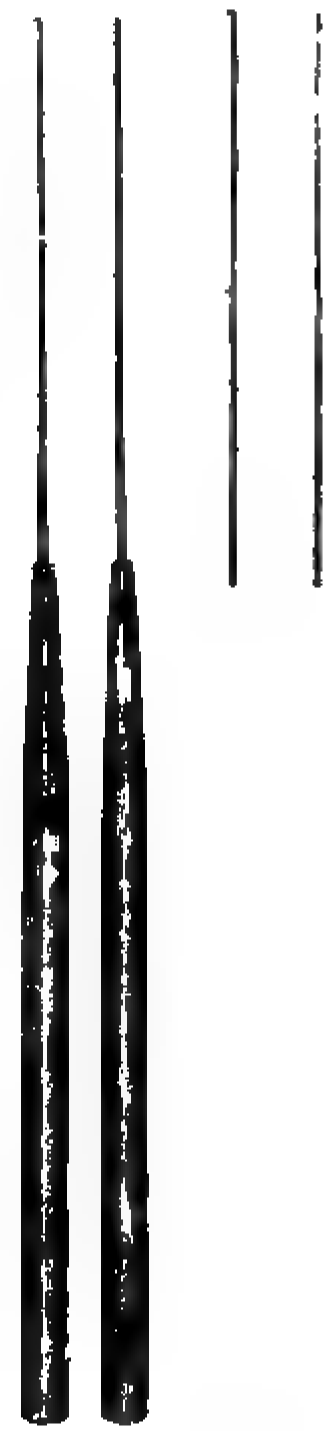


FIG. 125.



In all cases, and by whatever method, the orifice of exposure should be large and nearly on a line with the axis of the tooth, so as to admit of easy manipulation, especially if the barbed broach or bent wire are employed; and when a pulp is removed by such an operation the wound usually heals by first intention, and no periosteal irritation results.

The actual cautery consists in thrusting a wire, heated to a white heat, up the canal; but as this is considered a barbarous method, it is not resorted to by practitioners in this country. Besides, periosteal inflammation is often a result of its use, and the pain following its application is sometimes very severe. The galvanic cautery is preferable to the actual cautery for the destruction of pulps, applied by means of a bent platinum wire maintained at a white heat.

Arsenious acid* has long been used in connection with acetate of morphine and creosote, or carbolic acid, to devitalize the pulp; the arsenic and morphine being mixed in equal parts and taken up on a small pellet of cotton saturated with creosote, which is introduced directly upon the exposed portion of the pulp, and the cavity filled with wax or cotton saturated with a solution of gum sandarach and alcohol. The morphine was formerly supposed to modify the irritating action of the arsenious acid; but since this has been discovered not to be the case, its use has been dispensed with by many who prefer no other combination than creosote or carbolic acid. Water, alcohol, and ether have also been employed as substitutes for the creosote. The arsenious acid is at times combined with an equal part by weight of pulverized charcoal, on account of the antiseptic properties of this latter agent and also on account of its mechanical action in preventing the dentine from absorbing what is intended for the pulp alone. A favorite mixture is known as "nerve paste;" but when a definite quantity of the arsenious acid is desired for application to a pulp it is better to employ the dry form. Various formulæ are in use for the preparation of devitalizing mixtures, such as equal parts by weight of arsenious acid and acetate of morphine; three parts by weight of arsenious acid to two parts of morphine; two parts of arsenious acid and one part of morphine. Creosote or carbolic acid is generally employed to combine the ingredients and also to act as a sedative. Although the thirtieth part of a grain of arsenious acid is the average quantity generally employed to devitalize the pulp, yet the amount may be

* The employment of arsenious acid for the destruction of an exposed dental pulp and the relief of the pain arising therefrom, originated with the late Dr. Spooner, of Montreal; and in 1835 it was recommended to the profession by his brother, Dr. S. Spooner, of New York, in an excellent popular treatise upon the teeth.

reduced to the $\frac{1}{100}$ of a grain in many cases when judiciously used. The length of time the preparation should be allowed to remain varies from six to twenty-four hours. Dr. J. F. Flagg recommends the following formula:—

℞.	Arsenious acid,	gr. j.
	Acetate of morphine,	gr. ij.
	Carbolic acid,	gtt. iij.

A very convenient form of devitalizing mixture is that known as "nerve fibre," which consists of a combination of arsenic, creosote, tannin and opium incorporated in the fibres of cotton or lint, which is afterwards dried and cut up into shreds. Dr. James Gordon has suggested the following method of devitalizing pulps, which is claimed to be less painful than that heretofore employed: After carefully cleansing the cavity saturate a very small pledget of cotton, held by a foil carrier, with benzole, and then apply to the cotton a little nerve paste, and place the whole directly upon the exposed pulp and cover it by loosely filling the cavity with cotton saturated with sandarach varnish. If a solution of caoutchouc in benzole is employed to saturate the first pledget of cotton to which the nerve paste is applied, the preparation will better retain its place in the cavity and is less liable to be displaced when the retaining pledget of cotton saturated with sandarach is introduced.

When arsenious acid is applied to temporary teeth the quantity employed should be very minute, and many are disposed to question the safety of its application to such teeth, as the agent may be absorbed by the very vascular structure and injure the surrounding membranes. Not unfrequently cases are met with where repeated applications of the preparation fail to destroy the vitality of the pulp, which is doubtless owing, in cases where the organ is fairly exposed, to its inflamed condition at the time the application is made, which enables it to resist the absorbent action of the arsenic. In such cases a preparation composed of tannin and creosote has proved serviceable.

Arsenic when applied to a pulp excites inflammation, and as this condition passes off the agent is absorbed and devitalization follows. Too great a quantity of arsenic will defeat the object, and in many cases its devitalizing action is prevented by the high degree of inflammation present, so that it is necessary to reduce the inflammatory condition before a successful application of the devitalizing agent can be made.

The time the arsenious acid is permitted to remain in the tooth is important, and should be determined by the condition of the pulp, the class of tooth, the structure of the tooth, the age of the patient,

and the susceptibility to the influence of the agent. The time necessary for the action of arsenious acid varies from six to twelve and in some cases twenty-four hours, when minute quantities are employed.

As the degree of inflammation excited by the arsenic depends upon the quantity of the agent employed, it is much the safer and better plan to apply small quantities than an amount which will devitalize the pulp by one application; for in the latter case there is danger of the effects being carried to the peridental membrane through the apical foramen.

It is often very difficult to retain the devitalizing agent on fractured teeth when it becomes necessary to destroy their pulps. A method pursued by some is to apply a minute quantity and cover it with gutta-percha, which is held in position by ligatures. Another method suggested by Dr. Rich is to secure the arsenical preparation by surgeon's rubber plaster, passing it around any portion of the crown which remains.

The late Dr. Harwood, of Boston, who was strongly opposed to the use of arsenious acid as a devitalizing agent, described his plan of accomplishing this object by the surgical method, as follows:—

"I first effect such an opening as will enable me to approach the exposed pulp in the line of its axis, or as nearly so as circumstances will permit. Then, having carefully but sufficiently exposed the surface of the pulp, I pass down to the apex of the root, through the pulp, a small untempered steel instrument, with a trocar-shaped point, and revolving it once or twice sever the vessels and nerve. This, as any one knows who is accustomed to inserting artificial teeth, produces but a slight and momentary pain. I then, by means of minute instruments adapted to the purpose, endeavor to remove every portion of the severed pulp and lining membrane, and, as soon as the hemorrhage ceases, dry and fill the cavity.

"It should be borne in mind that at the point where the vessels and nerve in question enter the root the passage is much smaller than it is immediately within. This strait will be easily recognized when reached, by the touch, the instrument appearing to be arrested by an obstacle, and not by being wedged in a narrow passage. Care should be taken, I think, that the instrument is not allowed to pass through the strait, either by being too small, or by being revolved there till it cuts its way through. For by wounding the parts without the tooth and forcing particles of bone out upon the parts external to the root the danger of an unfavorable result would be greatly increased."

Dr. E. C. Kirk suggests the following devitalizing mixture, which

he states has given uniform satisfaction as a prompt obtunder and immediate relief from pain:—

℞. Acid. arsenic pulv., cocaine hydrochlorat, āā	gr. xx.	
Menthol cryst.,	gr. v.	
Glycerine,	q. s.	M.

To make a stiff paste.

Dr. James Truman recommends the following devitalizing mixture as prompt and painless: Take the amount of arsenic it is proposed to employ and add an equal quantity of iodoform, and on a glass slide, by means of a 5 per cent. solution of carbolic acid, make a paste. The whole is carried to the pulp on a piece of cotton the size of a pin-head, in which it is incorporated, and covered with a cap of platinum or of red gutta-percha, and over this a temporary filling of wax or cotton saturated with sandarach.

On the different methods of destroying the nerve Dr. J. H. Foster says: "It is a difficult matter, and I have generally found it utterly futile, to attempt to induce patients to submit to the removal of the pulp by *extraction* or *excision* with *instruments* in those cases in which it becomes necessary to destroy vitality before the teeth can be filled. To obtain the consent of the patient by a representation of the advantages in its immediate effects of this mode of treatment by *extirpation*, as contrasted with the more slow and uncertain practice by the aid of *chemical agents*, has been my earnest endeavor. I do not remember a single case of the removal of the dental pulp by an instrument —the gold being inserted into the dental cavity immediately after the hemorrhage has been checked—which has resulted in alveolar abscess."

Dr. Foster, however, generally employed arsenious acid with morphine, one part of the former to four of the latter, applied on a small pellet moistened with creosote. After applying this directly over the pulp, he covered it with a cap to avoid pressure; then filled the external cavity with some soft material which will exclude moisture. At the end of forty-eight hours he enlarged the dental cavity, removing its contents to the apex of the root; then, after waiting another forty-eight hours, he proceeded to fill the canal, leaving the cavity in the crown to be filled at a subsequent sitting.

In performing this operation on molar teeth, where there is a probable chance of a favorable issue and the preservation of these teeth is particularly called for, he thought it important that the excavation should be done at intervals, so as to cause as little irritation at each sitting as possible, and that the filling of the different cavities in the tooth be also proceeded with in like manner.

Dr. Maynard was the first to perfect the method of using arsenious acid as a devitalizing agent, and many years ago he adopted the following plan: Expose the pulp as much as possible, apply the arsenic, and cap the orifice with a cup-shaped plate of lead, the convex side outward. Keep this cap carefully in place and fill the cavity over it with cotton, into which white wax has been worked, in such a way as not to shut in and compress any air which might press upon the pulp. This packing will keep the arsenical preparation perfectly dry for twenty-four hours, or longer.

After removing this packing and the preparation, he proceeds to remove the pulp. Instead of attempting to do this at once, he begins by cutting on every side of the orifice, so much enlarging it as to be enabled to remove the pulp without pressing the contents of the cavity upward.

His probes were objects of peculiar interest, especially those for extirpating the pulp. Some of them were made from the main-spring of a watch, by filing or grinding them sufficiently narrow to enter the smallest space which he wishes to probe. In this way he secured the most perfect *spring temper*, a point not easily attained in so frail an instrument as a probe adapted to this purpose. These probes were bearded by cutting them with a sharp knife—the beard pointing backward. With different sizes of these and other probes, and by enlarging the cavity from time to time, he removed the pulp to the extremity of the root.

In the destruction of the pulp of a tooth, the late Prof. C. A. Harris employed both mechanical and chemical agents. He had been in the habit for more than twenty years of occasionally extirpating the pulp to the extremity of the root by introducing a very small untempered instrument, with spear-shaped point, though not at first with the view of afterward filling the pulp cavity. He had also used the actual cautery and arsenious acid. To the last-named agent, as used by most dentists for destroying the vitality of teeth, he was at one time strongly opposed, and believed a vast amount of injury was produced by it; but he afterward concluded that with proper care and judicious after-treatment it might be used with safety and, in most cases, with advantage. He employed it for destroying the vitality of the pulps of the molar and bicuspid teeth, and occasionally applied it to the incisors and cuspids. As a general rule, however, when he wished to destroy the pulp of one of the last-named teeth he extirpated it by thrusting a small instrument up the pulp-cavity to the extremity of the root. When he used arsenic he applied about the thirtieth or fortieth part of a grain with an equal quantity of morphine, placing it on a small piece of raw cotton

moistened with creosote or spirits of camphor, and sealed up the cavity with white or yellow wax. At the expiration of seven or eight hours he removed the wax and arsenic, and afterward the pulp of the tooth. If the portion in the root was still sensitive he applied it a second time; but he seldom found it necessary to do so. There is comparatively little objection to the use of arsenious acid provided it is judiciously and carefully employed and not allowed to come in contact with the gums, as it is the only agent that will destroy the pulp effectively and with the least pain in a comparatively short time.

Such agents as nitric acid and carbolic acid are also employed to destroy pulps; the method being first to apply the carbolic acid to the exposed surface of the pulp, and then the nitric acid on a small disk of card-board cut a little larger than the orifice of exposure and retained for half a minute. After this is removed a second application of the carbolic acid is made and the pulp removed from the cavity by means of a barbed broach. Some employ a fine splinter of wood dipped in nitric acid, which is thrust into the previously obtunded pulp. Repeated applications of carbolic acid, chloride of zinc, nitrate of silver, or caustic potash are also preferred by some to arsenious acid for devitalizing agents. A piece of hard elastic wood, shaped to conform to the pulp-canal, and suddenly forced up on the pulp by the blow of a condensing hand-mallet, is recommended by some as being almost painless.

CHAPTER XI.

SENSITIVENESS OF DENTINE.

WHILE inflammation of the soft tissues exhibits such symptoms as pain, redness, heat and swelling, the dentine of a tooth in a similar pathological condition does not indicate all such manifestations; for, owing to its peculiar structure, there is no redness, on account of a want of red globules, nor swelling, on account of the density. There is, however, exalted sensibility, and to such a condition the term inflammation has been applied. Inflammation of the dentine is due to exposure of this structure consequent upon the breaking down of the enamel or protective covering, and its degree will depend upon the organic structure of the teeth, susceptibility to irritation, and the nature of the irritating agents. Teeth that are very vascular and highly organized are often extremely susceptible to the action of irritating substances, and such a state of

exalted sensibility may at times be occasioned by disturbance of other and remote organs, such as the uterus, for example.

The direct cause of inflammation of the dentine is irritation of the fibrillæ, which occupy the dentinal tubuli and are processes from the odontoblasts, and proceed through these tubules to the periphery of the dentine, and, in some cases, even beyond this structure. The odontoblasts are arranged in a layer on the outer surface of the pulp, and slight irritation of the ends of the fibrillæ, which proceed from these cells, results in the formation of secondary deposits of dentine.

The greatest sensitiveness is generally found where the union of the dentine with the enamel occurs, for the reason that at this point the nerve fibres terminate, and which accounts for the greater sensitiveness of dental caries in its incipient stage.

A tooth is sometimes exceedingly sensitive when the pulp is not exposed; but, in the majority of cases, this need not deter the operator from removing the decayed part and filling the cavity, for the inflammation of the dentine may be confined to a thin lamina directly beneath the carious matter, and the only inconvenience it will occasion the patient will be a little suffering during the operation, and slight momentary pain for a few days, whenever anything hot or cold is taken into the mouth. But when the sensibility is so great that the patient cannot bear the removal of the diseased part, as occasionally occurs, it may be allayed by the application of chloride of zinc to the cavity of the tooth for from three to six minutes. When this is done, care should be taken to prevent it from coming in contact with any of the soft parts of the mouth, on account of its active escharotic properties.

For the destruction merely of morbid sensibility in the solid structures of a tooth, chloride of zinc, according to the author's experience, although somewhat less certain in its effects, is superior to any preparation dependent for its active properties upon the presence of arsenic. With this agent it rarely happens that more than five minutes are required to obtain the desired effect. Although a powerful escharotic, it does not, as all arsenical preparations are liable to do, produce any deleterious effect on the pulp of the tooth. It is thought, however, in some cases to modify the texture of the dentine; and, in the opinion of some practitioners, so much so as to render it more easily acted upon by decaying agencies. When first applied it excites a sensation of heat, followed by burning pain; but these soon subside, and on removing it from the tooth the parts of the cavity with which it was in contact will, in a large majority of the cases, be found totally insensible to the touch of an instrument.

The chloride may be applied directly to the cavity of a sensitive tooth, without being combined with any other substance, on a little raw cotton or lint; or it may be made into a paste by mixing it with an equal quantity of flour, the moisture which it absorbs from the atmosphere being sufficient for the formation of the paste; or it may be mixed with a little pure anhydrous sulphate of lime in an impalpable powder and then applied to the tooth. But before this is done as much of the decomposed dentine as possible should be removed, and the application should be held firmly in contact with the part of the cavity on which it is intended to act. A single application will generally suffice to destroy the sensibility to a sufficient depth as will enable the operator to remove any remaining portions of decayed dentine without pain; but repeated applications are sometimes necessary.

The fortieth or fiftieth part of a grain of arsenic is sometimes applied, and allowed to remain from one to three hours; but there is great danger of destroying the vitality of the pulp by the use of this agent, even though it be permitted to remain for only a short time; hence its use is not recommended. Tannin or tannic acid in alcoholic solution, or in creosote and glycerin, are valuable applications for this pathological condition of the dentine. Nitrate of silver, chromic acid, and the terchloride of gold are also used for the same purpose—the nitrate being applied in either a solid form or in a concentrated solution; and while it affects the dentine to a greater depth than either the tannic acid or chloride of zinc, yet its action is not so painful as the latter.

Creosote and carbolic acid are extensively used for this condition of dentine, and are among the safest of these agents.

Chloroform applied to the cavity on a small piece of cotton will often give a temporary insensibility, and has the merit of being quite harmless; which cannot be said of chloride of zinc, arsenic, or cobalt —the first sometimes acting injuriously upon the dentine, the two latter upon the dental pulp.

A mixture of chloroform and aconite, equal parts, is also recommended; also, carvacrol, oil of cloves, oil of cedar, oil of eucalyptus, glycerine and tannin, creosote and tannin, camphor and chloral solution, camphorized ether, oxide of calcium (this latter, however, causes considerable pain when first applied), carbonate of sodium, menthol, thymol, the sesquichloride of chromium, a mixture of equal parts of tincture of aconite and a saturated solution of iodine, carbonate of potash, equal parts of sulphate of morphine and gum camphor, ethylate of sodium, carbonate of potash and glycerine, equal parts of crystallized carbolic acid and caustic potash, made by mixing into a crystalline paste and known as the "Robinson

Remedy," and the insertion of temporary fillings composed of oxychloride of zinc or oxyphosphate of zinc, or Hill's stopping.

An efficient means for the application of heat as an obtunder of sensitive dentine is the "Dento-Electric Cautery," represented in Fig. 126. The looped-wire of this instrument is rapidly passed across the sensitive surface, and obtunds it to such a degree as to produce an immunity from suffering of considerable duration.

FIG. 126.

In the instrument a platinum loop, A, is held by set-screws, B, in contact with metal conductors which pass through a hard-rubber handle. The battery wires are coupled to the two terminals, C. The appliance is held in the hand somewhat in the same manner as a pen or pencil in writing, and the circuit is closed by pressing upon the spring, D, with the forefinger, when the resistance of the loop causes it to become heated. The platinum loop when destroyed is readily and inexpensively replaced.

A safe way of meeting the difficulty in slight cases is to have the excavators and burrs very sharp and well tempered, and to cut firmly and decidedly (for the scraping of a dull instrument is quite as painful as the cut of a sharp one), making cuts "which sweep the circumference of the cavity," or in a direction from the pulp chamber.

Friction, by means of a burnisher, is also recommended as being effectual where the position of the sensitive surface will permit of its use.

When painful escharotics are employed, the sensitiveness of the dentinal surface should first be obtunded by the application of a solution of sulphate of atropine, or other local anæsthetic.

Having noticed the agents usually employed for destroying morbid or hyper-sensibility in dentine, we will proceed to notice a few of the non-conductors against thermal influences that have been used for the accomplishment of the same object. Among the substances which have been employed for this purpose are *asbestos, gutta percha, cork, oiled silk;* also such filling materials as *Hill's stopping*, the *oxychloride* and *oxyphosphate* of zinc.

Asbestos, as a non-conductor of caloric, certainly possesses every desirable property, and is as indestructible in a tooth as gold. When used for this purpose the purest variety should be selected. A small

pellet made from the filaments of this mineral, placed in the bottom of a cavity previously to filling, will effectually prevent irritation of the pulp from impressions of heat and cold. The cavity, however, should be first properly prepared, washed with tepid water, and made perfectly dry. The asbestos may occupy from one-fourth to one-sixth of the depth of the cavity after the filling has been introduced and consolidated.

A thin layer of gutta percha placed in the bottom of the cavity, previously to introducing the gold, is as effectual in preventing the transmission of impressions of heat and cold as asbestos, and can be more conveniently applied. There is, however, a preparation of it, known as "Hill's stopping," which is better than the simple article for a temporary filling.

Cork is an equally good non-conductor of caloric, but some object to its use on account of its being more destructible than asbestos or gutta percha; but cut off, as it necessarily would be in the bottom of the cavity beneath the filling, its liability to undergo any change would seem to be rendered wholly impossible. But it is of a more porous nature than gutta percha, and cannot be adapted as perfectly to the inequalities of the floor of the cavity. There is also danger, in introducing the filling, of forcing some portions of the gold through it, unless a very thick piece be used. Oiled silk has also been used in some cases very successfully, but it is not as good a non-conductor as either of the afore-mentioned agents.

The filling materials known as oxychloride of zinc and oxyphosphate of zinc often prove effectual in preparing a sensitive cavity for a more durable metallic filling. For the method of applying these agents, and also Hill's stopping, the reader is referred to the chapter on "Materials Employed for Filling Teeth."

Should it, however, be necessary to fill the cavity with a more permanent material, such as metal, and the inflammation is confined to a portion of the dentine, this may be protected by a layer of the non-conducting material and the metal introduced over it.

CHAPTER XII.

PERIODONTITIS.

PERIODONTITIS, pericementitis, dental periostitis, peridentitis, as the affection is variously named, denotes inflammation of the investing or peridental membrane of the roots of the teeth, a tissue highly vascular and very susceptible to inflammatory conditions,

and may, in a great majority of cases, be regarded as a premonitory stage of alveolar abscess, as it rarely occurs before the pulp has been deprived of its vitality.

Although the death of the pulp generally precedes the inflammation of the peridental membrane, which usually originates in the apical space, yet this inflammation may arise before devitalization takes place; but in such cases the pulp is involved to such a degree that its recovery is impossible. The peridental membrane is confined between the walls of the alveolar cavity and the root of the tooth, and as a consequence is incapable of expansion when its vessels are engorged with blood, and, endowed with a large supply of nerves, which render the membrane very sensitive even in a normal condition, it becomes excruciatingly painful when inflamed.

Inflammation of the periosteum of a tooth may be *acute* or *chronic*, the acute form being generally due to direct local irritation and the chronic form to systemic influences. Each variety is modified in its character by the state of the constitutional health and by the causes concerned in its production. The premonitory symptoms of the acute variety are a slight sensation of uneasiness and tension, a feeling of fullness about the affected part, and a desire to press the teeth together. Pressure appears to afford temporary relief, but the uneasy feeling returns on the pressure being withdrawn.

The symptoms are soon followed by a dull, heavy, and continuous pain, and the affected tooth appears to be longer than the adjoining ones, and is really so, owing to the increased thickness of the investing membrane of the root. Occlusion of the teeth gives rise to severe pain, and there is an inclination to keep the jaws apart. The appearance of the gums at this stage of the affection also indicates the existence of disease in the investing membrane; they become very tender and swollen, and change from a pale rose color to a deep red or purple opposite the root of the affected tooth.

At first the inflammation is confined to the free margins, but soon it becomes more general, until the whole of the gum about the root of the tooth is involved. Although the pain increases in severity, it yet preserves the same character, and even when not continuous, it seldom ceases for any great length of time. At length suppuration occurs, and we have the condition known as alveolar abscess, this process sometimes extending to nearly every part of the periosteum, causing the entire death of the tooth, and often followed by erosion of the root and necrosis of the alveolus. When favored by a cachectic habit of body, it often extends to the periosteum of the jaw, followed by suppuration and necrosis. The following case will give some idea of the severity it occasionally assumes :—

In 1840 a poor girl, aged fourteen, was brought to the author. About three months before she had been taken to a barber tooth-drawer for the purpose of having the first left inferior molar extracted. The crown was broken off, the roots left in the socket. Inflammation supervened. This soon extended to the periosteum of the entire bone from the second bicuspid to the coronoid process; as it was permitted to run its course uninterruptedly, it terminated in necrosis and exfoliation of all this portion of the bone (Fig. 127), the anterior extremity of which, when first seen by the author, had passed through the integuments of the lower part of the face and protruded externally. A few days after it was removed without difficulty.

Fig. 127.

Acute inflammation of the peridental membrane having terminated in suppuration, sometimes, instead of subsiding altogether, degenerates into a chronic form, and when favored by some constitutional vice, as the scorbutic, venereal, or scrofulous, it often gives rise to the destruction of the socket and loss of the tooth.

The acute form of periodontitis is readily diagnosed by the pain caused by pressure on the affected tooth, which distinguishes it from such diseases of the dental pulp as irritation and inflammation or pulpitis. Besides, the pain of periodontitis can always be definitely located, whereas in pulpitis its exact location is often doubtful; again, the dental pulp is influenced by thermal changes to such a degree as to very greatly increase its sensibility when diseased, whereas, the peridental membrane is not so influenced, and its sensitiveness is not increased to any marked degree by thermal changes, except when the pulp-cavity contains gas, which expands from heat and induces pressure on the tissues beyond the apical foramen.

Chronic inflammation of the peridental membrane is generally preceded by the active form of the disease, but it may assume the chronic form at the commencement. In this case it is complicated with tumefaction of the gums and discharge of puriform matter from between their edges and the necks of the teeth. Chronic periodontitis is but a modified form of the acute, and is manifested by soreness of a tooth, which may either be so slight as to occasion very little annoyance, or be very considerable, with apparent congestion of the gum about the tooth, and sensitiveness of a greater or less degree when the organ is pressed upon.

After the loss of vitality in the pulp of a tooth, the peridental membrane is very susceptible to inflammation, owing to the irritation to which it is subjected, and also to the weakened condition of this membrane, and its increased function in supplying the cementum and dentine with nourishment.

CAUSES.

Periodontitis, in most instances, is the result of inflammation of the pulp of a tooth, either from direct exposure or the presence of an irritating substance, such as the remains of a dead or decomposing pulp, salivary calculus, the free use of arsenious acid, the injudicious use of agents employed for obtunding the sensitiveness of dentine, the action of mercurial remedies, etc. It may also result from the loss of an antagonizing tooth, violence, proximity of a metallic filling to the pulp, overhanging portions of a filling, and the presence of caries beyond the margin of the gum. Besides the local causes enumerated, there are also constitutional causes, such as a syphilitic taint through an infiltration of lymph and serum into the periosteum, or between it and the root of the tooth or alveolar walls of the socket; also rheumatism, especially in those who have been subjected to an excess of mercury, and scrofula, which produces a form of periostitis common to children. This affection may also extend from the periosteum of one tooth to that of adjoining teeth.

TREATMENT.

The treatment of periodontitis will depend upon the causes producing and influencing the disease, and the condition of the general system. The first thing to be attended to is the removal of all irritants from the pulp-cavity, such as a decomposing pulp, after which the congestion of the affected part may be relieved by the use of such agents as produce counter-irritation, or by depletion.

When the pulp of the tooth is inflamed it should receive immediate attention, and if the pulp is dead, all the debris should be removed from its pulp-cavity by means of nerve instruments, and syringing with tepid water. All deposits of calculus should be removed from the teeth, and also all dead teeth and roots which are useless and cause irritation. The pulp-cavity should then be thoroughly disinfected by iodoform, eucalyptus, iodine, carbolic acid, salicylic acid, or sanitas, etc. After the application of the disinfecting agent, the pulp-cavity should be loosely filled with cotton saturated with an antiseptic agent, but sufficiently close to prevent the entrance of fluids. If a secretion of pus is present the application

may be frequently changed, and thus prevent the pressure of the secretion from causing pain. In severe cases where the above treatment does not prove effectual, counter-irritation may be resorted to; the gums may be scarified, or such agents be applied as iodine and creosote, tincture of capsicum, and tincture of iodine. An excellent application is composed of equal parts of the officinal tincture of iodine and tincture of aconite root applied to the gum two or three times daily, in the acute form of the affection. Previous to the application, the gum should be dried, and afterwards the cheek kept from coming in contact with it until a metallic pellicle is formed. Cantharidal collodion is also an excellent counter-irritant, and is applied to the gum, after the surface is dried with a napkin, by means of a camel's-hair brush, taking care to protect the lip, and to prevent moisture from interfering before the ether in the preparation evaporates and an artificial cuticle is formed. Within a few hours blistering results, and the periostitis is effectually relieved. Another method of producing counter-irritation is to make a deep incision in the gum over the affected root, and to introduce into this a small pellet of cotton or lint saturated with creosote or carbolic acid, which is retained for from one to five days, the time depending upon the persistence of the inflammation, taking the precaution to change the dressing every day. The application of a solution composed of equal parts of tincture of aconite, tincture of opium, and chloroform, is often very serviceable; also a small linen bag containing capsicum, one side of the bag being covered with leather, to protect the cheek. Lead-water, in the proportion of a fluidounce to two fluidrachms of laudanum, applied in the same manner as the agent before named, has also been successfully used. Depletion may be accomplished by means of the gum lancet, or by the use of leeches or cups.

Hypodermic injections of morphine have also been resorted to for the relief of the intense pain of this affection, such as a solution of morphine or tincture of opium, some ten to twenty drops being injected with a suitable syringe beneath the mucous membrane; also, with good effect, the application of rhigolene or ether spray until the gum about the affected tooth is blanched. As a topical application, rhigolene has been recommended, applied to the gum on a pellet of cotton after free scarification.

Constitutional treatment is also serviceable, such as the administration of saline cathartics. Bromide of potassium in a dose of twenty-five grains, or the same quantity of the bromide combined with five drops of the tincture of veratrum viride, and repeated every four hours, will often prove serviceable in incipient alveolar

periostitis. A preparation known as *mercurius vivus*, the third decimal trituration, given in small doses two or three times a day, has been recommended by Prof. Chase, and used successfully by others in relieving acute periostitis. During the treatment a cap of gutta-percha, moulded to the crowns of one or two teeth on the opposite side of the jaw, will protect the affected tooth from any irritation which may be caused by the occlusion of the opposing ones, and thus facilitate the restoration. For the treatment of the chronic variety of periodontitis, the reader is referred to "Chronic Inflammation and Tumefaction of the Gums."

CHAPTER XIII.

ALVEOLAR ABSCESS.

An alveolar abscess is a collection of pus in a sac attached to and closely embracing the root of a tooth, and is the result of inflammation of the tissues of the apical space, where its inception invariably occurs. The peridental membrane having become the seat of acute inflammation, plastic lymph is effused at the extremity of the root. This is condensed into a sac or cyst, which closely embraces the root near its apex, the walls of lymph become vascular, and perform the functions of secretion and absorption, and as suppuration takes place, pus is formed in the centre of the sac. The inflammation in the meantime having extended to the gums and neighboring parts, they swell and become painful, and as the pus accumulates in the sac, it distends and presses upon the surrounding walls of the alveolus, which, by a chemico-vital process, are gradually broken down. By absorption, through pressure, an opening is ultimately made through one side of the alveolar cavity, when the pus, coming in contact with the investing soft structures, presses upon them and causes their absorption also, or it may follow the side of the root to the margin of the gum, and thus outlets are effected for the escape of the accumulated matter.

In some cases the pus may separate the periosteum from the bone of the alveolar cavity and form a receptacle for itself between the membrane and alveolar wall, and if not promptly discharged may cause necrosis of the bone.

The pus of an alveolar abscess, in the case of young persons, usually

finds an exit through the root canal of the tooth, especially when the abscess is formed upon the apex of the root, owing to the large size of the foramen of a deciduous tooth. In adult persons the escape of the pus generally takes place through the alveolar wall and the soft tissues opposite the root of the affected tooth.

The secretion of an alveolar abscess, especially when an inferior molar is affected, may find its way to the surface of the cheek or neck, and considerable deformity be caused from the cicatrix resulting. In some cases the sinus of an abscess may invade the duct of a salivary gland, and necessitate the operation for salivary fistula, before a cure can be effected; but the secretion may escape from a more remote point. It may make for itself an opening through the cheek or through the base of the lower jaw, and be discharged externally; or it may pass up into the maxillary sinus, or through the nasal plate of the superior maxilla, or form a passage between the two plates of the bone, and escape from the centre of the roof of the mouth.

The formation of abscess in the alveolus of an inferior dens sapientiæ is sometimes attended with inflammation and swelling of the tonsils and of the muscles of the cheek and neck. The author has known trismus to result from this cause.

The pain attending the formation of alveolar abscess is deep-seated, throbbing, and often so excruciating as to be almost insupportable. But as soon as suppuration takes place, it loses its severity, and with the escape of the pus nearly or altogether ceases; but the tooth, from the thickened condition of the alveolo-dental periosteum, particularly at the apex of the root, often remains sore and sensitive to the touch for several days. The energies of the disease, however, having been expended, the secretion of the pus in the majority of cases wholly ceases, and the opening in the gums closes. From the increased susceptibility in the alveolo-dental periosteum to morbid impressions, occasioned by the presence of a tooth deprived of a large portion of its vitality, a recurrence of the inflammation is liable to take place, when pus will be again formed and the passage for its escape re-established. But the pain attending any subsequent attack is seldom so severe as in the first instance.

There are some cases, however, in which the inflammation, instead of subsiding altogether, degenerates into a chronic form. In this case, the sac at the extremity of the root continues to secrete pus, though the quantity is usually small, and the openin in the gums remains unclosed.

Persons of a scrofulous diathesis are very liable to this affection, which, in these cases, very soon assume a chronic form.

In the extraction of a tooth which has given rise to the formation of abscess, the sac is often brought away with it. Two teeth in which this had happened, taken from the upper jaw—one a cuspid and the other a first molar—are represented in the accompanying cuts (Figs. 128 and 129). In the case of the molar the sac is attached to the palatine root. Both of these teeth were extracted previously to the formation of an external opening for the escape of the matter.

FIG. 128. FIG. 129.

Although in the majority of cases the sac is attached to the apex of the root, yet it is not unusual for the point of attachment to be on the side of the root, as in the case of the superior front teeth and bicuspids, or in the bifurcation of the roots, in the case of the molars, for example. When the sac is situated upon the side of the root of a superior front tooth, it is generally upon the labial surface, and when it is situated at the apex of the root of a molar tooth the palatine root is the one generally affected. The temporary teeth are much more liable to this disease than the permanent teeth, and the superior incisors more susceptible than the inferior teeth of the same class.

But the treatment of inferior teeth affected with abscess, especially the bicuspids and molars, is often more difficult than that of the superior, on account of the gravitation of the pus and the impossibility in many cases of making an opening through the alveolar process so low as the extremity of the root, owing to the muscular attachment being so high on the ridge.

The character of the secretion differs considerably in different cases; instead of the yellowish-white appearance that pure or laudable pus presents, and which may be present in some cases of alveolar abscess in good constitutions, a highly vitiated, acrid fluid, with either a diminished supply of pus corpuscles or an entire absence of such corpuscles, usually distinguishes the secretion, which sometimes becomes very irritating in its effect upon living tissue. The systemic condition of the patient modifies the character of the secretion, as also does the nature of the local irritants.

The time required for the formation of alveolar abscess varies from three to ten or fifteen days, according to the violence of the inflammation. But a collection of pus may be detected by fluctuation under the finger, if applied to the tumefied gum one or two days before an external opening is spontaneously formed for its escape.

The size of the cavity formed by an alveolar abscess depends upon the severity of the disease and the susceptibility of the parts

involved. In some cases it is quite small and confined to the point of irritation, while in others it may be very extensive. Very severe pain accompanies this affection when the abscess is rapidly formed, owing to the distention occasioned and the inability of the secreting pus to escape. As soon as an opening is effected, however, the tension is relieved and the pain subsides. A great susceptibility to alveolar abscess exists in case of an inflammatory diathesis, and after a time it may assume a chronic character, when the secretion and discharge of the pus is continuous. Although the pain may not be more than a slight uneasiness, the acute form is productive of intense pain. There is also a difference in the extent of the inflammation affecting neighboring tissues, depending upon the activity of the irritants present, as in some cases of alveolar abscess the inflammation of adjacent parts may be very limited, while in others it may be very extensive.

The inflammation and pain attending the formation of abscess in the alveolar cavity of a tooth often gives rise to general febrile ymptoms, headache and constipation of the bowels. In the acute form of this disease the pain is intense, while in the chronic form, where the pus is constantly secreting and discharging, the sensation experienced is soreness and an uneasy feeling, with slight pain upon a change of temperature.

Chronic alveolar abscess generally follows the acute form, and results from a subsidence of the acute symptoms into others less painful, but more persistent. The chronic form is generally accompanied with a fistulous opening which, in its position and the direction of the canal, presents quite a variety of forms. The fistulous opening is usually, however, upon the gum over the root of the affected tooth; but in some cases the fistulous opening may close and the secretion from the abscess appear at a different point some distance from the original one. In other cases a chronic abscess may again assume acute symptoms, which may continue until a new exit for the secretion manifests itself at a more remote point. These chronic cases often cause a feeling of stiffness, caused by the pus burrowing through muscular tissue, as the secretion will generally follow a course which presents the least resistance. The direction of the pus is also influenced by gravitation, especially in abscesses connected with the inferior teeth. Abscesses connected with the inferior molar teeth sometimes discharge into the antrum and produce serious complications. Abscesses discharging on the face are generally connected with the inferior molar teeth and are influenced in this respect by gravitation, and the least resistance the pus in its burrowing course may meet with. The closure of a fistulous opening of a

chronic alveolar abscess may lead to the retention of the pus, which, on account of gravitation, in the case of an inferior tooth, penetrates to the surface along the border of the lower jaw. Abscesses connected with the superior teeth, when pointing on the face, generally discharge beneath the prominence of the malar bone, and the deformity resulting after the healing of the fistula is caused by the formation of a dense cord of new tissue which binds the skin permanently to the bone, and which must be severed in the treatment for correcting such a deformity.

CAUSES.

The immediate cause of alveolar abscess is inflammation of the peridental membrane, which is frequently incited by inflammation of the pulp and its subsequent death and decomposition, irritating matter being thus formed, which sooner or later affects the tissues of the apical space through the apical foramen of the tooth. Such a condition is often the result of filling the cavity in the crown of a tooth, and permitting a dead and decomposing pulp to remain in the pulp cavity. It may also be produced by mechanical violence, the irritation of a dead tooth, or by a drill accidentally passing from the canal through the side of the root into the periosteum, or by the presence of a portion of gold filling forced through the root of a tooth.

TREATMENT.

The treatment of alveolar abscess should be preventive rather than curative, for it often happens, after it has occurred, that the integrity of the parts is so impaired as to cause a recurrence of the affection. Although the secretion of pus may cease for a time, and the opening in the gums become obliterated, the tooth, being deprived of a large portion of its vitality, is liable, whenever the excitability of the peridental membrane is increased by any derangement of the general system, to give rise to a recurrence of the disease. Especially is this the case when the disease has assumed the chronic form. The formation of an abscess, therefore, should, if possible, be prevented by the use of such means as are referred to in the treatment of "periodontitis," a common termination of this disease being alveolar abscess. But should these means fail to prevent the formation of pus, we then have to resort to either therapeutic or surgical treatment, consisting in the removal of the irritant matter from the pulp-cavity.

An alveolar abscess of recent origin will yield more readily to treatment than one of long continuance, and the chronic form is much

more difficult to arrest, especially after the adjacent parts have become involved, than the acute form.

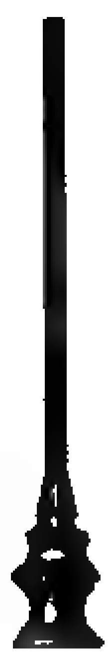
When constitutional derangement is present, general treatment, such as the particular condition indicates, must be resorted to. The local or surgical treatment consists in breaking up the sac of the abscess, and the evacuation of the pus as soon as possible, and ready access must be had to the point of accumulation in order to successfully accomplish such a result.

A sharp-pointed bistoury or small trephine may be employed to enlarge the fistulous canal when the pus has made an opening through the process and gum to the surface opposite the root of the tooth, and the sac broken up by means of nerve instruments, its remains being thrown off and healthy granulations developing without further treatment. In many cases, however, therapeutic treatment must follow the surgical, before a perfect cure is accomplished. The therapeutic treatment consists in first removing all irritating substances from the pulp-cavity, which should be freely opened to the apex of the root, and the application of disinfectant and antiseptic remedies. For cleansing the root, chloride of sodium injected into the canal answers a good purpose, to be followed by such agents as will cause the absorption or destruction of the sac containing the pus, such as creosote, carbolic acid, salicylic acid (applied in the solid form), nitrate of silver, iodine, etc. When a tumor appears on the gum from the presence of the pus which has penetrated the bone, the contents of the abscess should first be discharged by making an opening in the tumefied gum with a sharp lancet, provided the disease has been allowed to progress to such a degree as to render this operation necessary. The opening in the gum should not be allowed to close until the pulp-cavity has been exposed and the decomposed contents removed, when this cavity should be thoroughly disinfected by such agents as were referred to in the treatment of periodontitis. If no opening has been formed through the alveolar process the decay in the crown cavity should be removed, and the orifice of the pulp canal be so enlarged as to admit a nerve instrument or small broach, by means of which it can be cleaned out, and thus allow the matter to escape through the tooth. Tepid water should then be injected into the pulp canal by means of a small syringe, until all decomposed matter is removed, when one of the remedial agents mentioned above may be substituted for the tepid water, or applied on a strand of floss silk, which is carried to the apex of the root by means of a nerve instrument or broach. At the end of twenty-four or forty-eight hours, according to the character of the symptoms, this treatment is repeated, the

crown cavity during the interval being filled with cotton. A combination of several of the remedial agents is serviceable in obstinate cases, such as creosote and tincture of iodine, carbolic acid and tincture of iodine, or creosote and tannin in alcohol, which can be applied

FIG. 130

FIG. 131.



daily on floss silk, followed by clean silk introduced daily for two or three days, until the discharge ceases.

Figs. 130 and 131 represent Dr. J. N. Farrar's alveolar abscess syringe, for injecting iodine, carbolic acid, etc., and also an ordinary hard rubber syringe for the same purpose.

The following solution of Dr. Percy Boulton possesses therapeutic virtues of superior efficiency, especially after creosote, carbolic acid, eucalyptus, iodoform, iodine, or salicylic acid, have been employed to stimulate and disinfect the secreting surfaces to a healthy action:—

℞.	Tr. iodin. comp., ...	♏ xiv.
	Acid. carbolic. cryst. (fusa), ...	♏ vj.
	Glycerinæ, ...	ʒ viij.
	Aq. destillat., ...	℥ v. M.

This solution possesses antiseptic and stimulant properties.

The surgical treatment consists in making an opening, or enlarging the fistulous one, through the alveolus, opposite the extremity of the affected root, by means of a small trephine, drill, or chisel, first making a vertical incision in the gum with the lancet, and thus gaining access to the seat of the disease. The attachment of the sac to the root is then broken up by means of a delicate instrument which permits of being passed about the extremity of the root, and the wound in the gum kept open for a few days by inserting a tent, in order that the remains of the sac may escape, and such agents as tannin and glycerine, carbolic acid and glycerine, etc., may be applied. It rarely happens that this surgical treatment can be made through the pulp canal of the root and without an opening in the alveolar process. During treatment, to prevent the occlusion of the teeth, where this may be necessary, a cap of gutta percha can be moulded over the adjoining teeth by first softening this material in warm water. The excision of the apices of the roots of teeth, by means of a small trephine, and thus bringing away the sacs also, has been recommended as successful surgical treatment of alveolar abscess.

Dilute aromatic sulphuric acid is a very reliable application, either alone or combined with a small quantity of tincture of capsicum, in chronic cases of alveolar abscess of long standing associated with a necrosed condition of the margins of the processes.

Replantation is also resorted to, and in many cases may prove efficient, if care is exercised to remove all coagulated lymph and diseased membrane, and also to fill the canal permanently before returning the tooth to its cavity. Under favorable circumstances a tooth thus treated may become firmly attached within a few days.

When escharotic agents are injected into the pulp-cavity and through the fistulous opening in the process and gum, their contact with the mucous membrane may be prevented by the introduction of a Hill's stopping filling in the crown cavity, in the centre of which an opening is made to admit closely the point of the syringe, while at the same time the parts about the fistulous opening are protected

by bibulous paper, cotton, and napkins. When there is a tendency of the accumulated pus in the sac of an abscess upon one of the inferior teeth to discharge through an external opening in the cheek, or beneath the jaw, this result may be prevented by a free incision in the gum opposite the root of the affected tooth; should the discharge, however, through an external opening be inevitable, the immediate extraction of the tooth is necessary.

The application of fomentations and emollient poultices externally are rarely productive of any advantage, and may do harm by promoting the discharge of matter through the cheek or lower part of the face. When this occurs a depression, with puckering of the skin, is apt to remain after the escape of pus through the opening ceases and the orifice has closed, causing disfiguration of the face, which is caused by the formation of a strong cord of new tissue which binds the skin firmly to the bone.

It rarely happens, however, that anything more is necessary for the cure of the external opening than the extraction of the tooth which has given rise to the formation of the abscess.

The formation of an abscess in the alveolus of a lower wisdom tooth is sometimes productive of very serious and even alarming consequences. The following is one of several similar cases which have fallen under the observation of the author:—

In 1832 he was sent for in great haste to visit a physician who resided thirty miles in the country. He had been attacked two weeks before with severe pain in the left dens sapientiæ of the lower jaw. At the expiration of three or four days a physician was called in, who made several unsuccessful attempts to extract the tooth.

The inflammation now extended rapidly to the fauces, tonsils, and muscles of the jaw and face. Obstructed deglutition and a constant fever supervened, upon which repeated blood-lettings, cathartics, and fomentations applied to the face had little effect. His respiration was difficult, and the muscles of his jaws soon became so rigid and firmly contracted that his mouth could not be opened.

This was the condition of the patient when the author first saw him, which was the morning of the day following the one on which he was sent for. In addition to the treatment which had previously been pursued, an injection with two grains of tartar emetic was administered. About seven o'clock in the evening the fever was succeeded by alternate paroxysms of cold and heat. An effort was now made to force open his mouth with a wooden wedge. This was partially successful, but his teeth could not be forced asunder suf-

ficiently to admit of the introduction of the smallest-sized tooth-forceps. But while his jaws were thus partially separated he attempted to swallow some warm tea; in the effort an abscess burst and discharged nearly a tablespoonful of pus from his mouth, and it was supposed that double that quantity passed down into his stomach. This gave immediate relief, but it was not until about three o'clock in the afternoon of the next day that his jaws could be forced apart sufficiently to permit the extraction of the tooth which had caused the trouble. To the roots of this, which were united, there was attached a sac, about the size of a large pea, filled with pus. The patient recovered rapidly, and in a few days was quite well.

The following is the most singular case of alveolar abscess which has ever fallen under the observation of the writer. The subject was a lady about thirty years of age. She had been troubled with a dripping of pus from behind the curtain of the palate for about twelve months, and, becoming somewhat alarmed at its continuance, she called the attention of her family physician, Prof. Thomas E. Bond, to it, who carefully examined the case and endeavored to ascertain the place from whence the matter came. He soon satisfied himself that it was from the socket of a diseased tooth. Upon passing his finger around on the gums covering the superior alveolar border, he discovered a protuberance over the root of each upper central incisor nearly as large as a hazel-nut. This tended to confirm the opinion which he had formed as to the source from whence the matter came, and he requested us to visit the lady with him, which we did on the following day. On examining the case we advised the immediate removal of the affected teeth, and the more strongly as they were found to be in a necrosed condition.

The lady readily consented to the operation, which was performed on the following day. The discharge of matter from behind the curtain of the palate immediately ceased and the patient was relieved from an affection which had been a source of great annoyance. The pus from the abscess, in this case, instead of passing out through the nasal plates of the superior maxilla, passed back over the roof of the mouth and escaped in the manner described.

The author was once consulted in a case of a similar character to the one last noticed. The pus had found its way from the socket of a first superior molar to about the centre of the palatine arch, thence passed up into the posterior nares, and was discharged from behind the velum palati.

Inflammation of the investing membrane of the roots of an inferior dens sapientiæ may produce equally serious effects, without

occasioning the formation of an abscess in the alveolus. The eruption of these teeth is sometimes attended with like consequences. The irritation has, in some instances, extended to the lungs, and even been, in decidedly consumptive persons, the exciting cause of consumption.

The occurrence of alveolar abscess in the cavity of a temporary tooth is often followed by exfoliation of the sockets of several teeth, and sometimes of considerable portions of the jaw-bone, seriously injuring the rudiments of the permanent teeth and sometimes causing their destruction. The author saw a case a few years since, in which an abscess of the alveolus of the first lower temporary molar had occasioned exfoliation of the sockets of a cuspid and two molars. About one-half of the alveolar cells of the two bicuspids and the cuspid of the second set were also exfoliated, thus leaving their imperfectly formed crowns entirely exposed.

The treatment of the chronic form of alveolar abscess is generally confined to the removal of the cause of the affection, or at least to that of the secretion, which in simple cases consists in the cleansing of the pulp-cavity of all irritating matter which by its decomposed condition promotes the formation of pus. The application of disinfecting agents is then indicated, such as eucalyptus, iodoform, iodine, carbolic acid, salicylic acid, etc., etc.

Peroxide of hydrogen or sulphuric ether answer as good cleansing fluids in the form of injections by means of an abscess syringe. The entire tract of the abscess and fistulous opening should be subjected to the action of the disinfectant. Dr. G. V. Black has successfully employed a combination of carbolic acid 2 parts, oil of cinnamon 1 part, and oil of gaultheria 3 parts, as a stimulant disinfectant in the form of an injection. The presence of sanguinary calculus on the root of a tooth affected with the chronic form of alveolar abscess may retard or prevent the successful treatment until such an irritant is removed.

CHAPTER XIV.

NECROSIS AND EXFOLIATION OF THE ALVEOLAR PROCESSES.

THE alveolar processes, as well as other osseous structures, are liable to necrosis or loss of vitality. When their connection with the periosteum—the source from whence they derive their nourishment and vitality—is destroyed, death follows as a necessary consequence. The loss of vitality may be confined to the socket of a

single tooth, but more frequently it extends to several, and sometimes to the alveolar border, occasionally including a part or the whole of the jaw. It may occur in either jaw, but it is more liable to take place in the lower than in the upper. When confined to the alveoli the dead part is never replaced with new bone, but examples are on record of the regeneration of a part, and even the whole of the lower jaw.

When one or more of the cavities of the teeth lose their vitality, nature exerts all her energies to separate the dead from the living bone; this process, technically termed *exfoliation*, is supposed by some to consist in a sort of suppurative inflammation, but there is reason to believe it is effected by the action of a corrosive fluid poured out from the fungous granulations of the living bone in immediate contact with the necrosed part. During the process of exfoliation a thin, acrid matter is discharged from one or more fistulous openings through the gums or from between them and the necks of the teeth; the gums, having lost their connection with the necrosed bone, become soft and spongy, and assume a dark purple appearance, are preternaturally sensitive to the touch, and bleed from the most trifling injury.

In the admirable work of Mr. Fox, on the Natural History and Diseases of the Teeth, the case of a gentleman is related whose left lateral incisor became carious; inflammation and pain ensued, together with swelling of the gums and lip. Instead of consulting a physician he applied poultices to his face, until suppuration in the alveolus took place, causing the formation of an external opening through the gums for the discharge of the matter. After his mouth had remained for some time in this condition he applied to Mr. Fox, who, upon examination, found that not only had the decayed tooth become loose, but also one on each side of it. The first he extracted and discovered that the alveolus, from the destruction of the periosteum, was quite rough. The adjoining teeth, still continuing loose, were in a few weeks removed, and the slight force that was applied brought with them the alveolar process of the whole of the three teeth and also a considerable portion of the jaw-bone.

The author has met with several very similar cases, although all were not produced by the same cause, and he has several specimens in his possession, two of which were presented to him by his brother, the late Dr. John Harris.

He has also met with two cases of necrosis and exfoliation of the alveolar processes which are worthy of special notice. The subject of the first case was a gentleman of a strumous habit, about thirty years of age; the necrosis and exfoliation extended to

the cavities of all the teeth in the upper jaw. He had the nerve destroyed in the second bicuspid on the right side of the superior maxilla. We believe it was afterward removed and the pulp-cavity and root filled. About six weeks after, as nearly as we could ascertain, the cavity of the tooth became slightly painful, but as his suffering was not constant he supposed it would soon cease. The pain ultimately, however, began to increase, and by the latter part of the following September was so severe and attended by so much constitutional disturbance that he was induced to consult a physician. After having been under medical treatment for about two weeks the author was requested by the medical attendant to see him. The affected tooth was found to be loose and its cavity in a necrosed condition; inflammation had extended to every part of the alveolar border; the gums were very much swollen and nearly all the teeth sensitive to the touch. As the patient was laboring under considerable cerebral derangement, and as no advantage could be derived from the removal of the tooth at this time, it was deemed advisable to let it remain until exfoliation of the necrosed cavity should take place.

Without going into a detailed description of the local and constitutional treatment subsequently pursued, it will be sufficient to state that necrosis extended to the cavities of all the other teeth, except those of the second and third molars on each side of the mouth. In the course of about two months twelve teeth, together with their exfoliated cavities, and several large pieces of the maxillary bone were removed. It was hoped that the disease would stop here, but in three or four weeks the four remaining molars became very sore to the touch, and as purulent matter began to be discharged from their sockets it became necessary to remove them. Several small pieces of bone were exfoliated after the last operation, but at the expiration of about four months from this time his mouth was sufficiently restored to enable him to wear a temporary set of artificial teeth.

The subject of the second case was a lady of a cachectic habit, about thirty-five years of age. The necrosis resulted from inflammation of the alveolo-dental periosteum, occasioned by irritation produced by the roots of four incisors upon which pivot teeth had been placed, which, however, had been removed some two or three weeks before the author saw the patient. At this time necrosis had extended not only to the sockets of these teeth, but also up to the nasal crest of the maxillary bone, and the pro-

Fig. 132

cess of exfoliation had already proceeded so far that he was enabled to remove the entire piece, the appearance of which is represented in Fig. 132. A few weeks after the removal of this piece he again saw the patient, and, on examination, found a large portion of the palatine plate of the bone in a necrosed state; but the process of separation had not yet proceeded far enough to enable him to remove it.

The accompanying engraving, made from a drawing furnished the author by Dr. Maynard, represents a case of necrosis and exfoliation of a portion of the outer wall of the alveolar ridge, and the consequent protrusion of the roots of the teeth on one side of the mouth. The only facts which Dr. Maynard had been able to procure in relation to this case were contained in the patient's statement: "That in 1818 he took a cold, which settled in his upper jaw, and a large piece of the jaw-bone came away." The cast from which the drawing was made was taken in 1840, at which time the doctor cut off the apices of several roots which projected from the gums.

FIG. 133.

The alveolar process in relation with the superior central incisors appears to be more susceptible to necrosis than other portions, and this may be ascribed to such causes as diminished vitality occurring during conditions of depression and debility, the liability of such a prominent part to mechanical injury, and the effect of suppurative inflammation upon a portion of the process which possesses a less degree of restorative power than other portions better protected by muscular tissue.

Phosphor-Necrosis.—Necrosis of the bones of the jaws may also result from exposure to the fumes of phosphorus, as in the manufacture of matches, for example.

The disease, when due to such a cause, usually commences about a carious tooth, or in an alveolar cavity opened by the extraction of a tooth, and is sometimes complicated with affections of the lungs and air-passages.

In phosphor-necrosis there is a peculiar pasty appearance of the face, puffiness of the cheeks, and considerable pain and swelling in the affected jaw. Instead of the separation of a sequestrum, the dead bone becomes incrusted with a pumice-stone-like material, which adheres very firmly to it. Abscesses form and discharge externally through the skin of the cheek, and leave fistulous openings for the escape of the matter.

CAUSES.

The immediate cause of necrosis is the death of the periosteum, occasioned by inflammation. The cause of this, as has already been shown, is, in a large majority of the cases, dental irritation. Necrosis of the alveolar process occurs very frequently while the system is under the influence of mercurial medicines, and during bilious and inflammatory fevers, and certain other constitutional diseases, as syphilis, smallpox, etc. It may also result from mechanical injuries and the devitalizing effect of such agents as arsenious acid and chloride of zinc, when applied to destroy pulps of teeth, and so obtund the sensibility of dentine, etc., etc.

TREATMENT.

The treatment of cases of this kind consists in the removal of the sequestra, strict attention to cleanliness, and the free use of chlorinated washes. As soon as the dead portions of bone become separated from the living, and can be easily removed, they should be taken away with a pair of forceps. Should the removal of a considerable portion of the bone of the jaw be requisite, it is seldom necessary to interfere with the skin or make an external incision. The whole of the lower jaw can be removed in this manner by dividing it at the chin, and after separating all the attachments of the soft parts with the knife, drawing out each half at a time.

To correct the offensive odor and disagreeable taste occasioned by the constant discharge of fetid matter, washes of chloride of sodium may be employed.

There is no remedy, perhaps, that gives more satisfaction in the treatment of necrosed alveolar process and carious bone, than dilute aromatic sulphuric acid, combined with a small quantity of tincture of capsicum, using alternately the antiseptic known as "listerine." Prior to the application of such agents, the diseased parts should be syringed with tepid water, and this cleansing process continued throughout the entire course of treatment. While cold water will coagulate pus and unhealthy secretions, which are irritating by their pressure, warm water will produce the opposite effect, and is a useful adjunct to the antiseptic remedies. The removal of teeth in cases of necrosis of the alveolar process, should only be resorted to after mature consideration, for it frequently happens that the affection is confined to the labial walls, and if it is arrested new bone may be formed to such a degree as to give stability to the teeth in relation with the affected part.

Condy's fluid, or a solution of permanganate of potash, a weak solution of carbolic acid, or a solution of chlorinated soda, will

answer as disinfectants, and correct the fetor. The strength of the patient should be supported by stimulants and tonics, and good nourishment.

CHAPTER XV.

ABSORPTION OR GRADUAL DESTRUCTION OF THE ALVEOLAR PROCESSES.

THIS disease, to which the term "phagedenic pericementitis" is also applied, is a destruction of the walls of the alveolar cavities of the teeth, by a process of absorption which is always preceded by a corresponding loss of the peridental membrane, which is apparently caused by a chronic form of inflammation.

When treating of inflammation and tumefaction of the gums, the author adverted to the wasting of the alveolar cavities of the teeth, taking occasion to express a doubt that such operation of the economy ever manifested itself in the absence of all local disease.

It is always accompanied by a slight increase of redness, tumefaction, and a shrinkage of the edges of the gums (ulatrophia); but the diseased action here is so inconsiderable as often to attract little attention. It is also attended by a slight discharge of purulent matter from between the margin of the gum and tooth; but the quantity is so small that it usually escapes observation. The peridental membrane participates also in the diseased action, but this is so often confined to the corresponding wall of the process which is absorbed away, that the tooth often remains quite firmly articulated, after the wasting of its socket has proceeded even so far as to expose more than half of the root. Indeed, the affection appears to be closely allied to chronic inflammation and tumefaction of the gums.

The progress of the disease is often so slow that ten, fifteen, or twenty years are required to affect very perceptibly the stability of the teeth in their cavities. The commencement of this destructive process is usually first observed around the cuspid teeth; sometimes it makes its first appearance on the alveoli of the palatine roots of the first and second upper molars, and occasionally it goes on here for years before it affects the cavities of any of the other teeth.

FIG. 134.

The teeth, after their roots have been partially exposed, become,

as might naturally be supposed, more susceptible to impression from heat and cold, and more easily affected by acids or saccharine matters; but this is about the only manifest inconvenience experienced from the disease until the teeth begin to loosen in their cavities and are gradually displaced.

In Fig. 134 is represented a case in which the roots of the teeth have become considerably exposed by the gradual wasting of their sockets—the destruction being, as is usual, greatest toward the median line.

It appears to be questionable whether the destruction of the alveolar walls precedes or follows that of the peridental membrane, but from the nature of the latter tissue and its important functions in relation to the bone, we are of the opinion that the absorption of the latter occurs as a consequence of the destruction of the peridental membrane.

CAUSES.

The cause of this peculiar affection has never been very satisfactorily explained. Some have supposed that, inasmuch as it occurs most frequently in persons of advanced age, it results from a decline of the vital powers of the body, independently of local causes; but, as it is often met with in middle-aged persons whose constitutional health is unimpaired, we doubt the correctness of the opinion. In all cases which have come under our observation, whether in middle-aged or very old persons, the teeth indicated an excellent innate constitution, whatever may have been the state of the general health at the time. In every instance these organs were possessed of great density, and this fact is particularly noticed by Mr. Fox, who says:—

"In a majority of cases in which this disease occurs the teeth are perfectly sound, and from numerous observations, we think we may venture to assert that persons who have had several of their teeth affected with caries in the earlier part of life are not liable to lose, by an absorption of their sockets, those which remain sound; but where the teeth have not been affected with caries in the early part of life, persons, as they approach the age of fifty, and often much earlier, have their teeth becoming loose from absorption or a wasting of the alveolar process."

Now it is evident that teeth endowed with the power of resisting to so late a period of life the action of the causes of decay, to which all teeth are more or less exposed, must be possessed of extreme density, and, necessarily, a corresponding low degree of vitality. In view of this fact we have been led to the opinion that the teeth themselves may act to some extent as the mechanical irritants to the more

highly vitalized parts with which they are immediately connected, causing an increase of vascular action in the periosteum of the thin edges of the alveoli and margin of the gums. This abnormal condition is attended by a slight secretion of purulent matter observed between the edges of the gums and teeth. It is to the corrosive action of this purulent matter that the gradual destruction of the alveoli has by some been attributed; but it is more probably a result of the obscure disease than its cause.

This affection has been ascribed to the presence of salivary and sanguinary calculus, the use of charcoal powder as a dentifrice, and the application of a very stiff brush for cleaning the teeth; but when caused by these two latter agents the absorption does not progress to such a degree as when it is owing to a want of congeniality between the tooth and the more highly vitalized structure surrounding its root, or the other causes before referred to.

A later theory as to the cause of this affection has been advanced by Dr. Arkoevy, who believes that it is caused by a certain fungous formation found in close connection with the wasting of the alveoli and the gingival margin, as well as the subsequent loosening of the teeth; and that it is quite different from leptothrix buccalis, although it is in developmental relation with it.

Dr. G. V. Black also states that it is probable that the disease is caused and maintained by the presence of some peculiar fungus or form of micro-organism, and that it is infectious, this tendency being shown by the loss of the neighboring teeth. Others have ascribed this affection to a peridental inflammation arising from a gouty or rheumatic diathesis.

TREATMENT.

From what has been said concerning the cause of this affection, it is obvious that a cure cannot always be effected; its progress, however, may sometimes be arrested. The first step in the treatment is to remove all irritants, such as deposits of calculus, from the necks and roots of the teeth, and correct the nature of the fluids of the mouth abnormal in character by constitutional treatment, the use of lime-water, and a detergent dentifrice. Should such means prove ineffectual, the application of a solution of iodine and creosote or carbolic acid to the margins of the gums will often be of benefit in retarding the absorption and inducing a more healthy action. The secretion of the purulent matter, to the action of which some attribute the destruction of the alveoli, is the result of a disease in the alveolo-dental periosteum and the edges of the gums, arising from some peculiar physical condition of the teeth, the progress of which may be retarded by cleaning the teeth frequently and thoroughly,

using the precaution each time to remove the purulent matter from between the edges of the gums and teeth, lest, if allowed to remain it should become putrescent, and in this condition act as an irritant to the gum. For this purpose the parts should be washed with a solution of peroxide of hydrogen and bichloride of mercury (one grain of the latter to the ounce of the former), after which much benefit will be derived by applying a 30 per cent. solution of chloride of zinc, by means of a camel's-hair brush, to the margins of the gums. As the margin of the gum is inflamed, and a sulcus or pocket formed between it and the tooth, the use of the agents above referred to will promote healthy granulations.

The judicious application of pressure upon the gum has, in some cases, restored the receded portion, to a degree, at least.

Dr. G. V. Black suggests that when there is rapid destruction of the tissue and a considerable portion of the alveolar wall has been destroyed, and much of the peridental membrane detached from the root of the tooth, it is better to cut away some parts of this with instruments until firm bone is felt, but that care should be taken not to injure the gingival margin in any manner. The soft tissue farther up, however, may be lacerated without evil result, but the margin of the gum should be preserved so that it may close around the neck of the affected tooth.

Where it is desirable to preserve a valuable tooth, one of the roots of which has been denuded of gum and process, such root may be amputated by the use of a fissure-burr operated by the dental engine. The root should be cut off as close to its union with the crown as possible and the surface made smooth. It is advisable to fill all the roots with gold before amputating.

CHAPTER XVI.

HYPERTROPHY OF THE WALLS OF THE ALVEOLAR CAVITIES.

A TOOTH is sometimes slowly forced from its place by a deposit of bony matter in the bottom or on the side of the socket. Two, or even three, teeth may be gradually displaced at the same time, by exostosis of the alveoli. The deposition usually proceeds so slowly that one or two years are required to effect a very perceptible change in the situation of a tooth. The upper central incisors are more frequently affected than any of the other teeth, and the deposit occurs oftener at the bottom than on the sides of the alveoli. In the

first case, the tooth is gradually protruded from the socket; in the other, it is either pressed out of the arch or against one of the adjoining teeth. Irregularity in the arrangement of the teeth is, in this manner, sometimes produced, especially when more than one socket is affected at the same time. The central incisors are sometimes forced apart; at other times they are forced against each other and caused to overlap. The deposition of bone, however, being generally confined to the bottom of the sockets, the teeth are more generally thrust from their alveolar cavities. When this occurs with a person whose upper and lower teeth strike directly upon each other, it occasions much inconvenience, for the elongated tooth must either be thrown from the circle of the other teeth, or, by striking its antagonist, prevent the jaws from coming together.

CAUSES.

So little is known concerning the cause of exostosis of the sockets of the teeth, that it may seem almost useless to attempt an explanation of it. That it results from some irritation of the lining membrane is very generally believed, but what causes the irritation does not seem to be well understood. We have thought that it might sometimes be produced by pressure on the bottom of the alveolus, especially when the extremity is nearly as large as any other part of the root of the tooth. The susceptibility of the lining membrane to morbid impressions may sometimes be so great that the pressure of a very conical root may be sufficient to produce this effect; or, it may be produced by the pressure of a tooth which possesses only a very low degree of vitality. But in connection with this class of cases must be taken another, in which absence of all pressure would seem to be an inciting cause of alveolar exostosis; as where a tooth has lost its antagonist tooth or teeth, and in consequence becomes elongated. A diseased state of the gums can have no agency in the production of the exostosis, for it most frequently occurs in individuals whose gums are perfectly healthy; and if it were the result of any constitutional tendency, all the teeth would be as likely to be affected by it as those we have mentioned.

TREATMENT.

When the exostosis is on the side of the alveolar cavity, the tooth cannot be restored to its natural position; but when it is in the bottom of the cavity the elongated organ may, from time to time, as it is forced from the alveolus, be filed or ground off even with the other teeth; but in doing this care should be taken to avoid as much as possible the unpleasant jar which the file or corundum disk is so

apt to cause, and which might, in such cases, excite the periosteum to increased activity and a more rapid deposit. This will remove the deformity and prevent its displacement by the antagonizing tooth. By this simple operation, repeated as occasion may require, it is preserved for years, and rendered almost as useful as any of the other teeth. Steady pressure in the proper direction, applied to the crown of a tooth so affected, may also prove serviceable at an early stage.

CHAPTER XVII.

NECROSIS OF THE TEETH.

By the term *necrosis*, when applied to a tooth, is meant the death of the entire organ, or of the crown and inner walls of the root; for it often happens that a degree of vitality is kept up in the outer portion of the dentine and the investing cementum by the peridental membrane long after the destruction of the pulp and lining membrane. When other bones are affected with necrosis, the dead part is thrown off and the loss supplied by the formation of new bone. But the teeth are not endowed with the recuperative power which the process of exfoliation calls for.

The density of a tooth is not sensibly, if at all, affected by the mere loss of vitality; but so great a change takes place in the appearance of the organ, that it may readily be detected by the most careless observer. After the destruction of the lining membrane, the tooth gradually loses its peculiar semi-translucent and animated appearance, assuming a dingy or muddy-brown color; and this change is more striking in teeth of a soft, than in those of a hard texture. The discoloration, too, is always more marked when the loss of vitality has resulted from a blow, than when produced in a more gradual manner. The discoloration is partly owing to the presence of disorganized matter in the pulp-cavity, and partly to the absorption of this matter by the surrounding walls of dentine.

After the destruction of the lining membrane, the tooth may receive a sufficient amount of vitality from the alveolo-dental periosteum to prevent it from exerting a manifest morbid influence upon the parts with which it is immediately connected. Teeth have been retained under such circumstances with apparent impunity for many years. But when every part of a tooth has lost its vitality, it becomes an extraneous body. When this happens, inflammation of the cavity ensues, the gum around it becomes turgid and spongy, and bleeds from the slightest injury, and the organ gradually loosens and ultimately

drops out. In the meantime the diseased action frequently extends to the cavities and gums of the adjoining teeth.

The front teeth, being more exposed to injuries from violence, are more liable to necrosis than the molars.

CAUSES.

Necrosis of the teeth may be produced by a variety of causes, such as protracted fevers, the long-continued use of mercurial medicines, by caries and by external violence. The immediate cause, however, when not occasioned by a blow sufficient to destroy the vascular connection of the tooth with the rest of the system, is inflammation and suppuration of the lining membrane; but it may result from deficiency of vital energy and from impaired nutrition; for the author has met with several cases in which the loss of vitality could not be accounted for in any other way.

TREATMENT.

When a tooth deprived of vitality is productive of injury to the gums and to the adjacent teeth, it should be immediately removed; for, however important or valuable it may be, the health and durability of the others should not be jeopardized by its retention.

When necrosis of a tooth is apprehended, we should endeavor to prevent its occurrence by the application of leeches to the gums, and by gargling the mouth with suitable astringent washes, and the employment of such remedies as are useful in the treatment of alveolo-dental periostitis. If this plan of treatment is adopted at an early period, it will sometimes prevent the loss of vitality; but if long neglected, a favorable result need not be anticipated.

When the loss of vitality is confined to the crown and inner walls of the root, if the former is not seriously impaired by caries, it may be perforated, and the pulp-cavity and root cleansed and filled in the manner as directed in another part of this work. If the necrosed tooth is an incisor, the perforation should be made from the palatal surface, provided the proximate surfaces are sound. But previously to the introduction of a filling, the decomposed surface of the walls of the pulp-cavity should be completely removed, and if this does not restore the tooth to its natural color, the process of bleaching should be resorted to.

Bleaching Necrosed Teeth.—To improve the appearance of a necrosed tooth which has become discolored from the dentinal tubuli absorbing the coloring matter from the blood, the following method may be pursued: First, remove all decayed matter from the crown-cavity, where such a cavity exists, taking care, however, to leave the enamel

uninjured, and also as much of the dentine as is necessary for the strength of the tooth. Pursue the same course with regard to the canal in the root, cleansing this carefully by means of a syringe and tepid water after the removal of decomposed matter with the nerve canal instruments. When the discoloration is recent and not more than a red tinge in degree, such treatment as has been described may prove sufficient; should it not be, however, owing to the length of time the discoloration has existed, and the hue is a brown, dark brown or black, it is then necessary to resort to such agents as contain chlorine. Solutions of chloride of soda, chloride of lime, chlorate of potash, decompose organic substances by removing the hydrogen of their coloring matter. One of the most reliable of these preparations is the solution of chloride of soda, known as "Labarraque's Disinfecting Fluid," which may be introduced on a pellet of cotton and allowed to remain in the tooth from thirty to sixty minutes, according to the degree of discoloration present. Repeated applications may be necessary in some cases before the object desired is accomplished. To prevent the caustic action of these agents on the soft parts, the canal in the root should be partly filled prior to their introduction, and care taken to prevent their coming in contact with the mucous membrane of the mouth. The chloride of lime is introduced in the same manner as the chloride of soda, and is allowed to remain for five, ten, or fifteen minutes at a time, and its application repeated if necessary, the crown-cavity during the interval being protected by a temporary filling of Hill's stopping.

Dry, fresh chloride of lime made into a paste with dilute tartaric acid has given satisfaction in many cases as a bleaching preparation; and in recent cases or in slightly discolored teeth, the plastic filling material known as oxychloride of zinc, introduced into the crown cavity and worn as a temporary filling, has been effective in improving the appearance of a discolored crown. Oxalic acid carefully applied and protected, is also effective as a bleaching agent, applied in the form of a crystal introduced into the carious cavity and dissolved by applying to it a drop of water. Cyanide of potassium in solution will remove the stains caused by old amalgam fillings, but must be employed with great care, as it is a very active and deadly poison. In the use of all these agents it must be remembered that upon the cause of the discoloration will depend the efficacy of the chemical agent, and that chlorine will answer in some cases, owing to the nature of the agents instrumental in producing the discoloration, while cases of discoloration arising from the action of other agents will require such preparations as oxalic acid, etc.

After the action of the bleaching agent is no longer required a good practice is to fill the crown cavity of the tooth with either prepared chalk or carbonate of magnesia, which may be secured by a temporary filling, and permitted to remain for several days; or a filling of the oxychloride of zinc may be temporarily used, and a more permanent filling be subsequently introduced. Chloride of zinc in the form of crystals may also be employed as a bleaching agent; also chlorine water injected repeatedly by means of a syringe; also chlorate of potash and chloride of alumina. The peroxide of hydrogen has also been used successfully for bleaching discolored teeth, and its disinfectant properties add to its value. The following directions are given by Dr. A. W. Harlan:—

"After the root has been filled and the tooth is free from tenderness, apply the dam, dry the cavity, and remove all discolored dentine. Wash the cavity several times with fresh peroxide of hydrogen and place a few crystals of chloride of alumina in the cavity, moisten with the peroxide of hydrogen, and wait from three to five minutes; wash the cavity thoroughly with distilled water, then apply a solution of 30 grains of borax to the ounce of water until the acid is entirely neutralized. Dry the cavity with hot air, and paint the interior with copal-ether varnish. When it is dry mix oxychloride of zinc of the desired color and fill the cavity full; allow it to harden, then prepare the cavity for the gold filling and fill at once."

In the incisor teeth it is recommended to glue white unruled note paper to the labial walls with varnish and cover it with oxychloride, and afterwards fill with gold as a sequel to the bleaching operation.

The active agent is oxygen, and even when chlorine is used to bleach discolored teeth the cavity should be moistened with water, as the latter is essential, for the chlorine, having a great affinity for the hydrogen of the water, unites with it and liberates the oxygen, which is the active agent.

Electrolysis is also applied to the bleaching of discolored teeth by placing nascent oxygen in contact with the discolored surface. It is applied, according to Dr. W. B. Ames, as follows: First fill the root and moisten the cavity with acidulated water (one drop to the ounce of water, in order to render it a more effectual electrolyte), then apply a metal electrode connected with the negative pole of the battery in contact with the moistened surface of the margin of the cavity, and pass a platinum needle, connected with the positive pole of the battery, over the surface to be bleached. Upon closing the circuit the oxygen of the water is liberated at the positive pole near

the surface to be bleached, and the hydrogen is liberated at the negative electrode outside the cavity. Electrolysis is also recommended for the treatment of alveolar pyorrhœa.

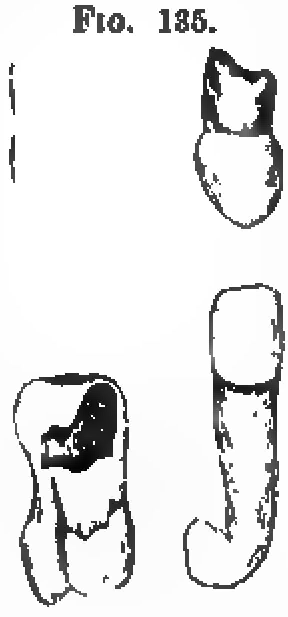
It should be remembered that the effect of these agents is to remove the organic or animal matter from the tooth-structure, and that their repeated application may cause the crown of the tooth to become frail and brittle.

CHAPTER XVIII.

HYPERCEMENTOSIS—EXOSTOSIS OF THE TEETH.

THIS disease is common to all bones, but it attacks no other part of a fully formed tooth than the root; for in the cementum alone, of the three osseous dental tissues, do we find that degree of vascularity which is a necessary condition of growth—normal or abnormal. It usually commences at or near the extremity, then extends upward, covering a greater or less portion of the external surface. It sometimes, however, commences upon the side of the root and forms a large tubercle; at other times the deposit of the new bony matter is spread over its surface, often uniformly, but more frequently unequally. When it exists in a nodular form upon the roots, this deposit offers a very serious obstacle in the extraction of such teeth. The osseous matter thus deposited has usually the color, consistence and structure of the cementum, though sometimes it is a little harder and assumes a yellower tinge. The enlargement is in fact an hypertrophied condition of this substance. Mr. Tomes, alluding to normal cementum, remarks: "When it is limited to a thin layer the lacunæ are altogether absent, and even canaliculi do not appear until a certain thickness is attained. In a longitudinal section of a front tooth the cementum near the neck will present a thin layer of transparent tissue, marked with faint indications of granularity, accompanied in some cases with an obscure linear appearance, suggestive of the idea that the calcification of parallel fibres had contributed to its production. Proceeding in the direction of the root the cement thickens and is traversed here and there by canaliculi; and still farther down lacunæ make their appearance, first as a single series, then, with an increased

FIG. 135.



thickness of the cementum, in numbers, the number generally depending upon the thickness of the tissue." Those singular anomalies occasionally met with, where enamel, dentine, and cementum are mixed up in a shapeless confusion, are no exceptions to the rule that exostosis is confined to the cementum; for though classed under this head, these cases arise from the disruption of the formative membranes (possibly the result of violence), each secreting its peculiar tissue.

The deposit of osseous matter is sometimes so considerable that the roots of two or more teeth are firmly united by it. Fig. 135 represents some common examples of hypercementosis.

Fig. 136.

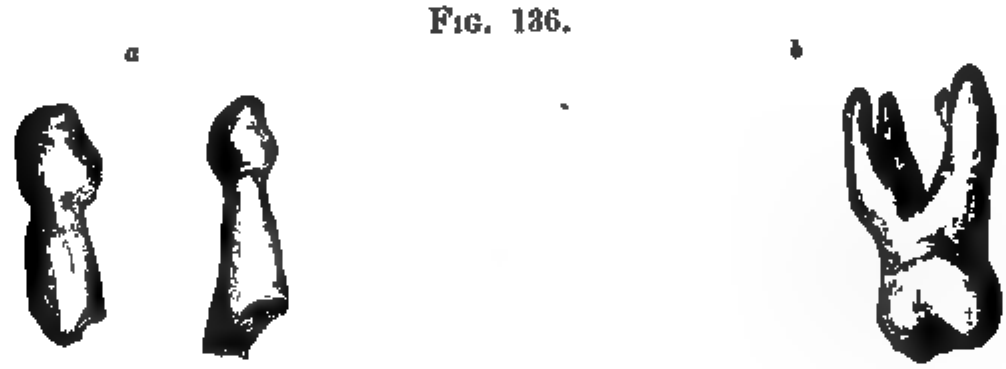


Fig. 136 *a* represents the circumscribed variety, and Fig. 136 *b* the diffused variety.

Hypercement is a product of the peridental membrane, and is formed in layers, the first of which is attached to the primary cementum in the same manner as the first layer of this latter substance is attached to the peripheral surface of the dentine. When the normal cementum is fully formed the peridental membrane becomes inactive as a hard tissue producer, until some pathological condition causes it to again assume such a function.

An extraordinary case of dental exostosis was sent to the author for examination by Dr. V. M. Swayze, of Easton, Pa. The tooth apparently is a dens sapientiæ, and the formation of the exostosis must have commenced with the dentinification of the pulp. It had spread over every part of the tooth, the crown as well as the root; it had ruptured and penetrated every part of the enamel membrane, but had not wholly destroyed the function of this organ, as nodules of enamel are seen in various parts of the exostosis. The tumor, including the tooth, is about as large as a common-sized hickory nut.

In one instance the author was compelled to extract four sound teeth and nine roots; yet the pain was not at any time severe, but it was constant and a source of great annoyance to the patient. The

following is one among the many cases which have fallen under his observation :—

Mr. S., of Baltimore, in the fall of 1845 called upon us for advice. Having for some time suffered pain in the first left superior bicuspid, he had applied two years before to a dentist for the purpose of having the tooth removed. In the operation the root, about three-sixteenths of an inch from its extremity, was fractured and left in the socket. In consequence of this, the gnawing pain with which he had for a long time before been troubled continued, and at the expiration of twelve months the gum over the remaining portion of the root became very much swollen, puffing out the lip to the size of half a hen's egg. The tumor, after a few days, was opened, and a large quantity of dark-colored, fetid, purulent matter was discharged, which, for a short time, gave considerable relief. The tumor, however, was re-formed, and opened some four or five times in as many months. At this time his gum was swollen and the upper lip puffed out in the manner just described. On opening the tumor about three tablespoonfuls of black matter, resembling thin tar, escaped. We then found, upon examination, that the outer wall of the antrum, immediately over the remaining portion of the root of the first bicuspid, was destroyed, and there was an opening through it large enough to admit the forefinger. Believing that the extremity of the root left in the socket was the cause of the disease, we immediately proceeded to extract it, which we succeeded in doing after removing the outer wall of the alveolus. The root was found, on removal, to be enlarged by exostosis to the size of a very large pea. The operation proved perfectly successful, the secretion of purulent matter soon ceased, and in a few weeks he was completely relieved from the troublesome affection under which he had so long labored.

Several years ago Prof. Gorgas, while demonstrating practical anatomy, discovered all the teeth in the mouth of one of the subjects (a negro girl about twenty-five years of age) to be in an exostosed condition. On the roots of one of the superior molar teeth the deposit of osseous matter measured three-fourths of an inch in diameter.

Teeth affected with hypertrophy of the cementum may be free from tenderness even under pressure or percussion, although the gum may, in some cases, be slightly congested; but the diagnosis of this affection is extremely difficult unless the enlargement of the root causes a prominence on the alveolar ridge, which is not often the case.

In many but not in all cases of this affection more or less discomfort and pain attend this deposit, owing to the enlargement of the cementum with consequent pressure upon the nerves. When such an enlargement is in proportion to that of the alveolus, little or no pain may be experienced. The pain arising from the enlargement of the cementum is at times moderate though persistent, but in some cases it may be excruciating, and may be referred to distant parts of the face and head or ear and about the terminal branches of the fifth pair of nerves, thus resembling neuralgia.

CAUSES.

Most writers concur in attributing the proximate cause of hypertrophy of the cementum to irritation of the peridental membrane; but this is not, as some suppose, necessarily dependent upon any morbid condition of the crown itself, for it often attacks teeth that are perfectly sound. It seems rather to be attributable to some peculiar constitutional diathesis.

It never makes its appearance on the roots of temporary teeth, nor upon permanent teeth until the sixteenth or twentieth year, when the dental tissues are completely calcified.

TREATMENT.

When it is possible to discover the existence of dental exostosis at an early stage, iodide of potassium in large doses, and painting the gum over the affected root with such counter-irritants as a saturated tincture of iodine, or cantharidal collodion to produce a blister.

The disease having established itself does not admit of cure, and when it has progressed so far as to be productive of pain and inconvenience to the patient the loss of the affected teeth becomes inevitable. When the enlargement is very considerable and confined to the extremity of the root, and has not induced a correspondent enlargement of the alveolus around the neck of the tooth, the extraction of the affected organ is often attended with difficulty, and can only be accomplished by removing a portion of the alveolar wall of the cavity or fracturing it.

Some are of the opinion, however, that the deposit of osseous matter may be arrested and absorption excited, so as to make room for that already deposited, by the administration of iodide of potassium, as referred to above.

CHAPTER XIX.

EROSION OF THE TEETH.

THIS is one of the most remarkable affections to which the teeth are liable, and occurs without any recognized cause. It consists in the gradual loss of substance on the labial surfaces of the teeth, and it attacks the incisors more frequently than the canines, and sometimes extends to the bicuspids and first and second molars. It first appears as a slight cup-shaped depression and increases over a limited space until it forms a continuous horizontal groove, as regularly and smoothly constructed as if it had been made with a file, about one line or less below the free margin of the gum, the eroded surface being generally very sensitive. (See Fig. 137.) After it has removed the enamel it commits its ravages upon the subjacent dentine, sometimes penetrating to the pulp-cavity. It rarely changes the color of the

FIG. 137.

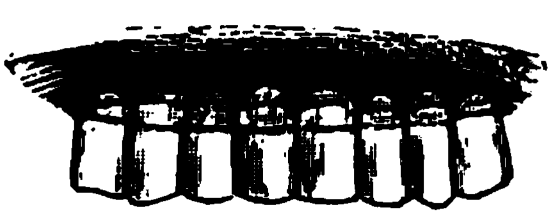
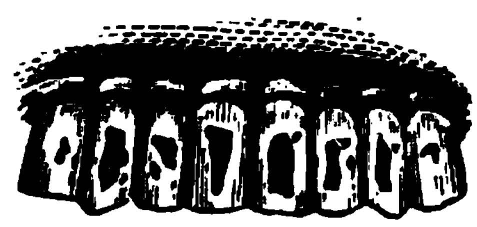


FIG. 138.



enamel, but the dentine, after it becomes exposed, assumes first a light, and afterward a dark brown color, retaining, however, a smooth and polished surface. This destructive process does not always commence at merely one point on the labial surface of the central incisors, as just described; it sometimes attacks several points simultaneously. (See Fig. 138.) As it spreads these unite, and ultimately a deep excavation is formed, with walls so smooth and highly polished that the tooth presents the appearance of having been scooped out with a broad, square, or round-pointed instrument. It is often confined to the incisor and canine teeth, and in some cases to the teeth on one side of the mouth only.

The progress of the affection is exceedingly variable. It is sometimes so rapid that the dentine becomes exposed within two or three years from the commencement of the disease; at other times its effect upon the enamel is scarcely perceptible for the first six or eight years after it makes its appearance. In the case of a lady whose teeth were thus affected the denuding process did not perforate the enamel for nearly twenty years. The dentine, after it is denuded of enamel, is generally quite sensitive and very susceptible to heat and cold.

CAUSES.

The cause of this singular affection has never been satisfactorily explained. It was first noticed by Mr. Hunter, who called it decay by

denudation, and supposed that it was a disease inherent in the tooth itself, and not dependent on circumstances in after life, for the reason that it attacks certain teeth rather than others, and is often confined to a particular tooth.

Some writers suppose it is occasioned by chemical action, to which, however, there appears to be many valid objections. Mr. John Tomes and also Mr. Salter ascribe it to the vigorous use of the tooth-brush or other friction, but such a cause is improbable. That this may increase the size of the horizontal groove is more than probable; that it may even in some cases determine the commencement of the groove is just possible. But no conceivable action of the brush could be an inciting cause of that form of the disease shown in Fig. 138. There is better reason for believing that this affection is due to a condition of enamel deficient in vital resistance, owing to some modification at the period of its formation, thus rendering it susceptible to the action of agents which it might, under more favorable circumstances, successfully resist, such as an acid contained in the mucus. Others have regarded it as dependent on faulty tooth structure, but microscopical examinations have failed to establish such a theory, as, according to Dr. Black, the erosion does not follow the developmental lines, which would be the case if portions of the teeth could be worn away on account of any softness from faulty development. The generally accepted theory is that this affection is caused by the action of an acid secretion, abnormal in character, produced on the inner surface of the lip, the motion of the latter assisting in the solution of the tooth-substance. Dr. W. D. Miller records the following experiment, which he regards as definitely settling the question as to whether or not erosion occurs in pulpless teeth: "We have all seen pulpless teeth which presented extensive erosions, but we have not been able to say that these erosions were not produced while the pulp of the tooth was still alive, and, as far as I am aware, no one has succeeded in refuting beyond all doubt the assertion that erosion attacks only teeth with living pulps. On the 7th of April, 1886, a piece of ivory was set, by means of cement, in the cavity of a right inferior bicuspid, where the loss of substance by erosion was so extensive that it would have exposed the pulp if the latter had not been protected by secondary dentine. On the 23d of April, 1888, the piece was removed for examination, and showed two very distinct parallel horizontal furrows. The surface had a very fine polish, characteristic of abraded dentine. No one examining the piece of ivory would hesitate for a moment to pronounce it a typical case of erosion."

TREATMENT.

In advanced stages of the affection its progress may be arrested by properly preparing the cavities and afterward filling them with gold; or, if the defective spaces will permit, porcelain sections or facings may be inserted. This, in the majority of cases, will prove successful. Should the grooves or pits when superficial become discolored it will be proper to use occasionally pumice or silex applied on a point of wood.

Erosion Associated with Abrasion.—This process was formerly treated under the title of "Chemical Abrasion," but as it appears to be an affection of the teeth in which the effects of both erosion and abrasion from mechanical causes are combined it is considered under the head of erosion. It is of rare occurrence and commences on the central incisors, proceeding thence to the laterals, the cuspids, and sometimes, though very rarely, to the first bicuspids. Teeth thus affected have, when the jaws are closed, a truncated appearance; the upper and lower teeth do not come together, and they are rather more than ordinarily susceptible to the action of acids or of heat and cold. In other respects little or no inconvenience is experienced until the crowns of the affected teeth are nearly destroyed.

Its progress, as in the case of simple abrasion of the labial surfaces, is exceedingly variable. It sometimes destroys half or two-thirds of the crowns of the central incisors in two or three years; at other times seven or eight years are required to produce the same effect. In one case which came under our own observation the abrasion had extended to the bicuspids, and the central incisors of both jaws were so much wasted that on closing the mouth they did not come together by nearly three-eighths of an inch; yet two years only had elapsed since its commencement. In another case, where it had been going on for seven years, it had not extended to the cuspids, and the space between the upper and lower incisors did not exceed an eighth of an inch. The subjects of these two were gentlemen—the first aged about twenty-eight and the other twenty-one.

FIG. 139.

Mr. Bell gives an interesting case (Fig. 139) of a gentleman whose teeth were thus affected: "About fourteen months since (1831) this gentleman perceived that the edges of the incisors, both above and below, had become slightly worn down, and, as it were, truncated, so that they could no longer be placed in contact with

each other. This continued to increase and extend to the lateral incisors, and, afterward, successively to the cuspids and bicuspids. There has been no pain, and only a trifling degree of uneasiness, on taking acids or any very hot or cold fluids into the mouth. When I first saw these teeth they had exactly the appearance of having been most accurately filed down at the edges and then perfectly and beautifully polished; and it has now extended so far that when the mouth is closed the anterior edges of the incisors of the upper and lower jaws are nearly a quarter of an inch asunder. The cavities of those of the upper jaw must have been exposed but for a very curious and beautiful provision; they have become gradually filled by a deposit of new bony matter, perfectly solid and hard, but so transparent that nothing but examination by actual contact could convince an observer that they were actually closed. This appearance is exceedingly remarkable, and exactly resembles the transparent layers which are seen in agatose pebbles, surrounded by a more opaque mass. The surface is uniform, even, and highly polished, and continues, without the least break, from one tooth to another. It extends at present to the bicuspids, is perfectly equal on both sides, and when the molars are closed the opening, by this loss of substance in front, is observed to be widest in the centre, diminishing gradually and equally on both sides to the last bicuspids."

The same causes may be ascribed for this affection as for those of erosion and abrasion. There is apparently some defect of structure, which renders the central portions of the tooth-surface susceptible to both erosion and mechanical abrasion, and the latter process may account for the smooth and polished surfaces which are invariably present.

From the fact that teeth thus affected continue to lose structure much more rapidly than the unaffected teeth of the same mouth do from mastication, and this, too, even after they cannot be brought in contact with each other, we cannot ascribe the affection to mechanical abrasion alone, and careful observations have failed to find any cause for such loss of substance in the dentine structure.

Dr. Black remarks that "the effect is certainly that of erosion, and is identical with that process as seen on the labial surfaces of the teeth and occurring independently of mechanical abrasion."

The only treatment for such cases is that of restoration, either by means of capping with gold or the attachment of sections of porcelain crowns, as no therapeutic treatment will control or arrest this singular disease.

CHAPTER XX.

ABRASION OF THE TEETH.

Were it true, as declared by Richerand, that the loss of the enamel occasioned by friction is repaired by a new growth, it would never suffer permanent loss from mechanical abrasion. But enamel and dentine, once formed, pass beyond the sphere of that reparative power found in other bony tissues where red blood circulates freely. New enamel is therefore never formed after the eruption of the tooth; and new dentine only within the pulp-cavity by the action of the odontoblasts.

The teeth rarely suffer much loss of substance from friction when the incisors of the upper jaw shut in front of those of the lower. It is only when the former fall directly upon the latter, that mechanical abrasion of the cutting edges of the front teeth can take place, and when this happens, they sometimes suffer great loss of substance. The crowns of these teeth are occasionally worn entirely off, while those of the molars and bicuspids are, comparatively, little affected. The lateral motions of the jaw, being in these cases unrestricted — and this motion being, of course, greater at the anterior than at the posterior part of the mouth — it necessarily happens that the front teeth suffer the most abrasion. Sometimes all the teeth are worn off alike; at other times, owing to the peculiar manner in which the jaws come together, the abrasion is confined to a few.

Abraded surfaces of teeth often become very sensitive, and the irritation affects the dental pulp in such a manner as to often favor the deposit of secondary dentine.

The rapidity of the abrasion depends greatly upon the manner in which the teeth antagonize, as sliding movements when the jaws are closed cause abnormal wear of the two surfaces. No doubt the grinding together of the teeth during sleep, the effect of nervousness, also facilitates the abrasion.

Abrasion is frequently caused by the loss of a number of teeth, which necessarily brings the entire work of mastication upon the remaining ones to such a degree as to rapidly wear them away, especially when the latter are few in number.

Mr. Bell believes that certain kinds of diet tend, more than others, to produce abrasion of teeth; in proof of which he tells us that sailors who, the greater portion of their lives, live on hard biscuits, have only a small part of the crowns of their teeth remaining. But the antagonism of the teeth has much more to do with it than the nature of the

food; though, of course, when they do not strike in such a way as to wear the cutting surfaces, very hard or gritty articles of food would make the abrasion more rapid.

When the front teeth of the lower jaw strike against the palatine surface of those of the upper, the latter are sometimes worn away more than three-fourths, and in some instances entirely upon the gums. We have seen the teeth of some individuals so much abraded in this way, that little of the crown remained, except the enamel on the anterior surface.

The wearing away of the crowns of the teeth would sooner or later expose the pulp, were it not that nature, in anticipation of the event, sets up an action by which layers of odontoblasts of the pulp resume their functional activity, and a portion of the organ, or the entire mass of it, at times is transformed into osteo-dentine. By this beautiful operation of the economy, the painful consequences that would otherwise result from the exposure of the pulp are wholly prevented.

TREATMENT.

The early correction of irregularities in the arrangement of the teeth, so that a proper antagonism of the teeth is secured, by which the cusps will fit into sulci of the opposing teeth, may be suggested as preventive treatment in many cases.

After the abrasion has occurred, the adaptation of caps of gold or other metal, or gold in the form of contour fillings, or enamel sections, to the cutting edges and grinding surfaces thus worn away, will often preserve and render useful teeth in such a condition.

CHAPTER XXI.

FRACTURES AND OTHER INJURIES OF THE TEETH FROM MECHANICAL VIOLENCE.

THE injuries to which teeth are subject from mechanical violence are so variable in their character and results as to render a detailed description impossible. The same amount of violence inflicted upon a tooth does not always produce the same effect. The nature and extent of the injury will depend as much upon the physical condition of the teeth, the state of the constitutional health, and the susceptibility of the body to morbid impressions, as upon the violence of the blow. Thus, a blow sufficiently severe to loosen a tooth might not, in one case, be productive of any permanent bad

consequences; while in another it might cause the death of the organ and inflammation of the adjacent parts, as well as necrosis of the alveolus.

A tooth of compact texture, and in a healthy mouth, may be deprived of a portion of its substance without any serious injury; but a similar loss of substance in a tooth not so dense in structure would be likely to produce inflammation and suppuration of the lining membrane, and possibly of the alveolo-dental periosteum. Hence, in order to form a correct opinion of the result of injuries of this sort, we must take into consideration not only the character of the tooth upon which the blow has been inflicted but also the state of the mouth and the health of the individual.

If the tooth is not loosened in its cavity any injury resulting from a loss of a small portion of the enamel, or even of the dentine, may be prevented by smoothing the fractured surface with a file, that the juices of the mouth and particles of extraneous matter may not be retained in contact with it. But if the tooth is loosened and inflammation of the investing membrane has supervened, leeches should be applied to the gums, and the mouth washed several times a day with some astringent lotion, until the inflammation subsides. For more detailed treatment the reader is referred to the chapter on periostitis.

When a tooth has been displaced from its cavity by a blow, and its vascular connection with the general system destroyed, necrosis must, as an almost necessary consequence, be the result. An imperfect union between the tooth and alveolus may sometimes be re-established by the effusion of a coagulable lymph, and the formation of an imperfectly organized membrane; but the tooth will ever after, from the slightest cold or derangement of the digestive organs, be liable to become sore to the touch, and in most cases will ultimately assume a muddy brown, unhealthy appearance.

The author has, on several occasions, replaced teeth that had been knocked from their cavities; and in some instances the operation was attended with success. The subject in one case was a healthy boy of about thirteen years of age, who, while playing bandy, received a blow from the club of one of his playmates, which knocked the left central incisor of the upper jaw entirely out of its cavity. He saw the boy about fifteen minutes after the accident. The alveolus was filled with coagulated blood. This he sponged out, and after having bathed the tooth in tepid water, carefully and accurately replaced it in its socket, and secured it there by silk ligatures attached to the adjacent teeth. On the following day the gums around the tooth were considerably inflamed, to reduce which in-

flammation he directed an application of three leeches and the frequent use of diluted tincture of myrrh as a wash for the mouth. At the expiration of four weeks the tooth became firmly fixed in its socket, but from the effusion of coagulable lymph, the alveolar membrane was thickened, and the tooth, in consequence, protruded somewhat. A slight soreness, on taking cold, has ever since been experienced.

Dr. Noyes, of Baltimore, mentioned to the author a case of a somewhat similar character. The subject was a boy about ten years of age. One of his front teeth was forced from its socket by a fall. It was replaced shortly after and in a few weeks became firm in its alveolus. Mr. Bell also mentions a case attended with a like result.

The alveolar processes and jaw-bones are sometimes seriously injured by mechanical violence. The author was requested by the late Dr. Baker, of Baltimore, to visit with him a lady who, by the upsetting of a stage, had her face severely bruised and lacerated. All that portion of the lower jaw which contained the six anterior teeth was splintered off, and was only retained in the mouth by the gums and integuments with which it was connected. The wounds of her face having been properly dressed, the detached portion of the jaw was carefully adjusted and secured by a ligature passed around the front teeth and first molars, and by a bandage on the outside, around the chin and back part of the head. Her mouth was washed five or six times a day with diluted tincture of myrrh. The third day after the accident Dr. Baker directed the loss of twelve ounces of blood; and in five or six weeks, with no other treatment than the dressing of the wounds, she perfectly recovered.

It often happens that the crown of a tooth is broken off at the neck. We have known the crowns of four, and in one case of thirteen, teeth to be fractured by a single blow. The subject of the last case was a fireman, who received an accidental blow on his mouth from the head of an axe, which broke off the crowns of all the upper and lower incisors, two cuspids, and three of the bicuspids of the inferior maxilla. The subject in the other case was a boy about twelve years of age, who, from a similar accident, occasioned by running up suddenly behind a man who was chopping wood, had the crowns of his upper incisors broken off. In both of these cases the inflammation which supervened was so great as to render the removal of the roots necessary. The crowns, roots and alveolar processes are sometimes ground to pieces, or the teeth driven into the very substance of the jaw. Mr. Bell says he once found a central incisor so completely forced into the bone that he thought it to be the remains of a root; but, on removing it, found it to be an entire tooth.

When the crown of a tooth has been broken off by a blow, and destructive inflammation results, the root should be extracted. When, however, the injury has not been sufficient to cause such a degree of inflammation, an artificial crown may be engrafted on the root; but it is very necessary that the inflammation should be entirely subdued previous to the operation of pivoting. If the tooth is to be replaced with an artificial substitute attached to a plate, the root should be first extracted, unless it is adapted to serve as a support for a section of bridge-work. In some cases, however, the root may be filled and be permitted to remain, but the practice is usually a bad one. The possibility of a fractured tooth reuniting was formerly doubted, but Wedl, in his "Pathology of the Teeth," refers to some fifteen cases in which union took place, some of which were due to the formation of secondary dentine and others to that of cementum.

CHAPTER XXII.

CARIES OF THE TEETH.

THE teeth are more liable to be attacked by caries than by any other disease, and this will now claim our attention.

Caries of a tooth is the chemical decomposition of the earthy salts of the affected part, sometimes, but not always, accompanied by disorganization of the animal framework of this portion of the organ. There is no affection to which these organs are liable more frequent in its occurrence or fatal in its tendency than this. It is often so insidious in its attacks and rapid in its progress that every tooth in the mouth is involved in irreparable ruin before even its existence is suspected.

Its presence is usually first indicated by an opaque or dark spot on the enamel, and if this be removed the subjacent dentine will exhibit a black, dark-brown, or whitish appearance. It usually commences on the outer surface of the dentine of the crown, beneath the enamel, at some point where it is imperfect or has been fractured or otherwise injured; from thence it proceeds toward the centre of the tooth, increasing in circumference until it reaches the pulp-cavity.

If the diseased part is of a soft and humid character the enamel, after a time, usually breaks in, disclosing the ravages the disease has made on the subjacent dentine. But this does not always happen; the form of the tooth sometimes remains nearly perfect until its whole interior structure is destroyed.

No portion of the crown or neck of a tooth is exempt from this disease; yet some parts are more liable to be first attacked than others; as, for example, the depressions in the grinding surfaces of the molars and bicuspids, the approximal surfaces of all the teeth, the posterior or palatine surfaces of the lateral incisors, and, in short, wherever an imperfection of the enamel exists.

The enamel is much harder than the dentine, and is by far less easily acted on by the causes that produce caries. It is sometimes, however, the first to be attacked, and when this happens the disease develops itself more frequently on the labial or buccal surface, near the gum, than in any other locality, often commencing at a single point, and at other times at a number of points. When the enamel is first attacked it is usually called erosion; but as this tissue does not contain so much animal matter as the subjacent dentine, the diseased part is often washed away by the saliva of the mouth, while in the dentinal part of the tooth it, in most instances, remains, and may be removed in distinct laminæ, after the earthy salts have been decomposed.

In very hard teeth the decayed part is of a firmer consistence and of a darker color than in soft teeth. Sometimes it is black, at other times of a dark or light brown, and at other times again it is nearly white. As a general rule, the softer the tooth, the lighter, softer, and more humid the caries. The color of the decayed part, however, may be, and doubtless is in some cases, influenced by other circumstances; perhaps by some peculiar modification of the agents concerned in the production of the disease.

FIG. 140.

* A transparent zone of dentine removed a short distance from and surrounding that which is undergoing decomposition consequent upon caries.

Commencing externally beneath the enamel, the disease proceeds, as before stated, toward the centre of the tooth, destroying layer after layer, until it reaches the lining membrane, leaving each outer stratum softer and of darker color than the subjacent one.

The dentinal tubuli become less distinct near the margin of the carious structure than is the case in the perfectly normal tissue in proximity with the pulp-chamber, and, according to Mr. John Tomes, has a zone-like form (the zone of Tomes), which he regards as a consolidation of the dentinal tubuli, an effort on the part of nature to place a line of demarcation between the healthy and carious structure.

Other writers, however, consider this zone of transparency to be the result of diseased action causing a complete exclusion of air from the tubuli, thus rendering them invisible when viewed by transmitted light.

The terms *deep-seated*, *superficial*, *external* and *internal*, *simple* and *complicated*, have been applied to the disease. These distinctions only designate different stages of the same affection. By complicated decay is meant caries which has penetrated to the pulp-cavity of the tooth, accompanied by inflammation and suppuration of the lining membrane and the death of the organ. The lining membrane, however, is not always inflamed by exposure, nor is inflammation invariably followed by suppuration.

The roots of the teeth frequently remain firm in their sockets for years after the crowns and necks have been destroyed, showing that they are less liable to decay than the crowns; but nature, after the destruction of the last, as if conscious that the former are of no further use, exerts herself to expel them from the system, which is effected by the gradual wasting and filling up of their sockets. After this operation of the economy has been accomplished they are frequently retained in the mouth for months, and even for years, by their periosteal connection with the gums. The effort of nature is confined more to the back than to the front teeth; it often happens that the last remain, after the destruction of their crowns, for many years, and sometimes without much apparent injury to the parts within which they are contained.

DIFFERENCES IN THE LIABILITY OF DIFFERENT TEETH TO DECAY.

Having explained at some length, in a preceding part of this work, the manner in which the physical condition of the teeth is influenced, it will not now be necessary to dwell upon this portion of the subject. It will only be requisite to state, therefore, that teeth which are well formed, well arranged and of a firm texture, seldom decay, and when they are attacked the progress of the disease is not rapid; whereas those that are imperfect in their formation and of a soft texture are more susceptible to the action of the causes which produce it; and when assailed, if the progress of the affection is not arrested by art, they usually fall speedy victims to its ravages. Just in proportion as the dentinal structure of the teeth is hard or soft, the shape of the organs perfect or imperfect, their arrangement regular or irregular, is their liability to caries diminished or increased.

The density, shape, and arrangement of the teeth are influenced by the state of the general health, and that of the mouth at the time of their dentinification. If at this period all the functions of the body

are healthily performed these organs will be compact in their structure, perfect in their shape, and usually regular in their arrangement. That the teeth should be thus influenced will not appear strange when we consider, as Richerand remarks, "that there exist amongst all the parts of the living body intimate relations, all of which correspond to each other and carry on a reciprocal intercourse of sensations and affections. Hence, if there is a morbid action in one part, other parts sympathize with it, rallying, as if sensible of the mutual dependence existing between them, all their energies to rescue their neighbor from the power of disease."

Increased action in one portion of the system is generally followed by diminished action in some other part; thus, for example, gastritis may be produced by constipation of the bowels; puerperal fever by diminished action in the heart, with an increased action in the uterus, etc. Hence, we may conclude that if the body at an early age be morbidly excited, its functions will be languidly performed, the process of assimilation checked, the regular and healthy supply of earthy matter in the bones interrupted, and, consequently, that the teeth which are then formed will be defective. Other parts of the body, in which constant changes are going on, if thus affected at these early periods, may afterward recover their healthful vigor; but if the teeth are badly formed they must ever, because of their low degree of vascularity, continue so; hence they will be more liable to decay than when dentinified under other and more favorable circumstances.

Capillary blood-vessels form a large part of every organ, the characteristic tissue of each being strictly *extra-vascular* (literally, *outside of the vessels*). Where the blood-vessels are most abundant, as in the nervous and muscular structures, growth and change take place rapidly and constantly, since almost every particle of the extravascular or interstitial tissue is in contact with the circulating fluid, the function of which is to supply material for growth and carry off waste matter. Hence such organs have great recuperative power and are modified by the varying conditions of the body. But the dentine and enamel of the teeth are vascular only during the period of development.

These structures, once formed, pass beyond the reach of the capillaries, except the layer of dentine in contact with the dental pulp. Hence the dental pulp may deposit new bone as a barrier against the caries; but the carious dentine itself is incapable of self-restoration.

"That the teeth acquire this disposition to decay," says Mr. Fox, "from some want of healthy action during their formation, seems to be proved by the common observation that they become decayed in

pairs; that is, those which are formed at the same time, being in a similar state of imperfection, have not the power to resist the causes of the disease, and therefore, at nearly about the same period of time exhibit signs of decay; while those which have been formed at another time, when a more healthy action has existed, have remained perfectly sound to the end of life."

Most writers are of opinion that the power of the teeth to resist the various causes of decay is sometimes weakened by a change brought about in their physical condition through the agency of certain remote causes, such as the profuse administration of mercury, the existence of fevers and all severe constitutional disorders.

Severe constitutional disorders, and the administration of certain kinds of medicine may not act directly on the teeth by altering their physical condition, and thus rendering them more susceptible to the action of corrosive agents; but they are indirectly affected in proportion as the secretions of the mouth are vitiated and their corrosive properties increased.

The following considerations establish, to our mind, the truth of what we have just stated. Artificial teeth of bone or ivory decay more rapidly after the profuse administration of medicine, or during the existence of any disease that tends to vitiate the secretions of the mouth, than at other times. Furthermore, teeth of so dense a texture as to be capable of resisting the action of the acidulated buccal fluids are not affected by constitutional disease; yet they are just as liable as those of a spongy texture, to any structural disease communicated from the general system.

The following is the result of our own observations: the gums and alveolar processes are sometimes destroyed by the use of mercury, so that all the teeth loosen and drop out without being affected by caries. The teeth of persons in whom a mercurial diathesis has been a long time kept up, or who have been for years suffering from dyspepsia, phthisis, fevers, or other severe constitutional disorders, often continue perfectly sound; while other teeth, under similar circumstances, frequently decay. Now, all this goes to prove, not that changes are effected in the structural condition of the teeth, whereby their predisposition to decay is increased, but that there are differences in the capabilities of different teeth to resist the action of the secretions of the mouth, made acrid by the affections just enumerated.

The author has noted the effects of mercury and of other medicines, as well as of constitutional diseases of the severest and most protracted kinds, and has always observed that—occurring *after* the development of the teeth—it was only as they impaired the healthy qualities of the fluids of the mouth that they affected these organs.

In fact, their density, their exposed situation, their functions, all would seem to indicate that such changes as take place in other parts of the body are not only unnecessary, but many of them are impossible, and designedly so, that they may more fully answer their purpose.

Dr. Good says "that caries of the teeth does not appear to be a disease of any particular age or temperament, or state of health." It is true it is not a disease of any particular state of health, further than that certain constitutional affections exert a deleterious influence upon the secretions of the mouth, and thus become indirect causes of decay of these organs. That it is not a disease of any particular age seems to contradict common experience, for it *comparatively* seldom happens that caries appears after the age of forty. The reason of which is obvious. Teeth of a loose texture or otherwise imperfect cannot resist the action of the causes of decay to which all teeth are up to this period of life more or less exposed; while those which from their greater density remain unaffected thus long are generally enabled, by the increased solidity they gradually acquire, to resist them through life. Teeth sometimes though rarely decay at fifty, or even a later period; but caries of the teeth generally may be said to be confined to youth and middle age.

The formation, arrangement, and physical condition of the teeth are sometimes influenced by hereditary diathesis, affecting the parts concerned in their production or the general system. That a morbid condition of the system on the part of either parent often predisposes their progeny to like affections is an axiom fully recognized in pathology, and a fact of which we have many fearful proofs.

That there is an hereditary tendency in the teeth to decay cannot, we think, be denied. But we believe it to be the result of the transmission of a similarity of action in the parts concerned in the production of these organs; so that the teeth of the child are, in form and structure, like those of the parent whom it most resembles, and from whom it has inherited the diathesis. The teeth of the child, if shaped like those of the parent, possessing a like degree of density, and similarly arranged, are equally liable to disease; when exposed to the action of the same causes they are affected in like manner and usually at about the same period of life. Such being the fact, is it unreasonable to conclude that judicious early attention may so influence the formation and arrangement of the teeth that their liability to disease may be diminished? Medicinal remedies and sickness have a powerful influence upon the dental tissues; first, through hereditary transmission of an impaired constitution; secondly, by their action upon the process of development, if given while the teeth are being formed. It is, then, to the differences in

the physical condition and manner of arrangement of these organs —whether in different individuals or in the same mouth—that the difference in their liability to decay is attributable.

Dr. John Allen remarks: "The nutritious substances in the food that we take are intended to build up all parts of the system—the hard tissues as well as the soft tissues. Of the food intended to build up these organisms, certain portions make bone and teeth. Now the particles of matter are deposited atom by atom, and the system is gradually built up. When we take food into the system it is converted into blood. This blood is conveyed through all parts in little corpuscles, which are freighted with the proper constituents to sustain and build up these organisms. These little corpuscles convey such constituents as are necessary for the production of bone, teeth, flesh, and the fat, and these various substances are deposited just where they should be. Now it is essentially necessary that we have these little vesicles freighted with the proper constituents, and duly freighted. How shall we know this? By taking the food just in the proportion that it is provided for us by our Creator and as it comes from nature's laboratory.

"Now we take this ground from the fact that, as a nation, we have worse teeth than any other on the earth. Now why is this? Simply because we change the proportions of these various constituents that our Creator has provided for us, by separating away what has been put there for the building up of the hard tissues.

"To prove this, let us look to other nations. They that do not change the proportions of the various constituents that enter into their bodies do not have decayed teeth.

"There is a constant change going on, and particles of matter are deposited atom by atom, and the system kept fully charged with the mineral elements of which these structures are built up. When you look at nations that do not change the proportions, you see no decayed teeth, and the history of these nations proves that their teeth are sound and beautiful to old age. What is the condition in our country? We *do* change these proportions. We *do* ignore the mineral elements provided for us, and we *do* have decayed teeth. We find that there are over twenty millions of teeth swept from our population every year. We do not take the material into our system that carries back, atom by atom, and keeps the hard tissues built up until the old particles pass away. The old particles pass away after they have served their purpose, and new ones then take their places.

"It is estimated that every child uses half a barrel of flour every year; and it is estimated that there are forty pounds of the bone-

forming material thrown out from every barrel that we use. The child takes its food on fine flour, and is deprived of twenty pounds in a year of this mineral element, which should be taken into the system in order to make those hard, flinty substances that our Creator intended. Now, by the time that child is twenty years of age it has been deprived of four hundred pounds of the elements which should have been taken into the system, and would have kept it charged sufficiently to have preserved these substances hard and flinty, as they should be.

"We sweep from our American population over twenty millions of teeth every year, and this should prove the theory that our tissues do undergo a change, and that, particle by particle, they pass away. As it is now, the teeth are becoming worse and worse every year; and not only this, but it becomes hereditary, and is transmitted from parent to child."

CAUSES OF DENTAL CARIES.

Predisposing Causes.—The causes of dental caries are divided into predisposing and exciting; among the former may be enumerated a defective constitution, either innate in the child as derived from the parent, or acquired from accidental influences to which the child has been exposed. Any condition of the system that will interfere with the proper elimination and application of the materials necessary for the formation of perfect structures may have a deleterious influence upon the teeth. Hereditary defects are quite common, the teeth of the child exhibiting the peculiarities of those of the parents. Impaired or diminished vitality from constitutional or local causes is also a predisposing cause of dental caries. Febrile conditions not only impair or diminish vitality, but change the nature of the fluids of the oral cavity to such a degree as to cause them to act upon the teeth very injuriously. Dr. George Watt remarks that "all diseases tend to weaken the dental organs, and thus are predisposing causes of decay. The most virulent are the *eruptive fevers*, such as typhus, typhoid, and scarlet fevers, measles, smallpox, erysipelas, etc. These fevers, and perhaps all diseases, predispose to decay in two ways. Weakening the entire constitution, they correspondingly impair the vitality of the teeth, and thus they have less power to resist the encroachments of the exciting causes of decay. And further, they deprave the secretions of the salivary glands and the oral cavity, rendering them liable to such decomposition as will result in the formation of exciting causes."

The same author also remarks: "That the condition of the teeth is influenced by heredity, no observing dentist can doubt. We have seen a family in which its female members, for four generations,

lacked the left upper lateral incisor. Sometimes one parent has good teeth, and good dental organs pertain to the family history, and the case with the other parent is just the reverse; we see children not usually having dental organs of an average between the two parents, but some of them copying one parent and some the other. The constitution of the parents, and especially that of the mother, may be unable to impart due vigor or proper materials in requisite quantities to the process of developing the teeth. From some cause, hereditary or otherwise, there may be a lack of lime salts in the system, or a lack of physiological ability to appropriate them and build them in properly with the organic matter of the teeth. Another condition may show the very best formed teeth while the alveolar processes, periosteum, and mucous membrane may be defective. A defective periosteum cannot give efficient nutrition; deficient development of the alveoli results in ineffectual support; while if anything is wrong with the mucous membrane we may have to contend with defective or depraved secretions." Dyspepsia affords an example of both a predisposing and an exciting cause of caries, as its effect is to generate an acid in the stomach which, by eructation, is brought into direct contact with the teeth. Malaria is a predisposing cause of dental caries, on account of the unfavorable conditions it induces; also such medicinal agents as vitiate the oral fluids and irritate the mucous membrane and periosteum, and interfere with the functions of the mucous follicles and salivary glands—mercury, for example; also salivary calculus, by its irritating effects upon the soft tissues in connection with the teeth and its influence upon the oral secretions; also want of exercise, which affects the stability of the teeth and causes absorption of the alveoli; also want of cleanliness, which may be regarded as one of the most common of the predisposing causes of dental caries; also artificial teeth improperly inserted or composed of bad materials; also improper dental operations, both as regards manner and time; also diseased teeth and roots, which are productive of irritation to the periosteum and gums; also sudden changes of temperature, which may cause an exalted sensibility of the dentine, diminish the vitality of the teeth, or produce checks in the enamel of frail teeth.

The fissures and grooves on the crowns of the molars and bicuspids are ascribed by some to an arrest of development, a failure of the enamel covering in its formation from the cusps toward the centre of the crown to come together and coalesce. Others, however, ascribe these defective places to be due to a rupture of the enamel organ at these points—a separation of the ameloblastic layer, thus separating the enamel rods and forming a fissure; such fissures being more common in teeth with prominent cusps.

Exciting or Immediate Causes.—The exciting or immediate cause of dental caries is conceded to be the action of agents chemically disintegrating the hard structures of the teeth, and which have their source in the vitiated secretions of the mouth, abnormal secretions from the stomach, the saliva, the mucus, and the decomposition of animal and vegetable substances. Fauchard, Auzèbe, Bourdet, and other French writers of the eighteenth century expressed the belief that dental caries is for the most part the result of the action of chemical agents; and the existence of an acid in the mouth capable of decomposing the teeth was conclusively proven by Dr. S. K. Mitchell in 1796. The theory that the decay of the teeth is the result of the action of external agents was first distinctly suggested to the dental profession of the United States about the year 1821, by Drs. L. S. and Eleazer Parmly. The late Professor Westcott, by a series of experiments made in 1843, found that "acetic and citric acids so corroded the enamel in forty-eight hours that much of it was easily removed with the finger-nail, and malic acid or the acid of apples, in its concentrated state, also acts promptly upon the teeth." Dr. W. D. Miller, an American dentist practicing in Berlin, deserves great credit for many careful investigations made to determine the cause of dental caries. He has lately given the results of over three hundred experiments, and has cultivated bacteria in order to determine the nature of a new fungus which is always found in the mouth and in carious dentine, and which is always said to be accompanied by a strong acid. Dr. Miller maintains that caries are caused either by the casual introduction of strong acids into the mouth or by the weaker acids formed by the fermentation of farinaceous or saccharine particles of food. After the destruction of the enamel, the process of disintegration attacks the organic matter, and first of all the micro-organism, which causes an endless variety of changes in the dentine, until finally it presents the appearance of a mass of decomposed matter intersected in every direction with fungi. Dr. Miller asserts that he has been convinced, by an examination of several hundreds of specimens, that after decalcification has taken place, the only change of any importance which occurs is produced by micro-organisms. And he further says that he sees "the need of little or nothing more than

FIG 141.

Longitudinal section of a carious bicuspid.

organic acids and fungi to account for all the phenomena of dental caries." "Give me these two factors and I can produce caries which will deceive the most experienced operators and microscopists."

Dr. Miller sums up in the following propositions the results of his investigations on the subject of dental caries:—

First. The contact of saliva with amylaceous or saccharine food (not to speak of nitrogenous food), or a solution of sugar or starch in saliva, kept at body temperature, invariably gives rise, in four or five hours, to a strong acid reaction, due to the generation of an organic acid.

Second. There must consequently be in the human mouth a constant, though variable, generation of acid, because of the impossibility of keeping the mouth perfectly free from food and from solutions of amyloids in saliva, which penetrate cracks, pits, and fissures, or are held by capillary attraction between the surfaces of the teeth in contact and there become acid by fermentation.

Third. The degree of acidity depends somewhat upon the length of time which has elapsed since partaking of food, and will be found greatest on rising in the morning.

Fourth. A cavity of decay in which saccharine or amylaceous food has remained for some hours must and will be found, always and without exception, to have an acid reaction.

Fifth. The extent to which any tooth suffers from the action of the acid depends upon its density and structure, but more particularly upon the perfection of the enamel and the protection of the neck of the tooth by healthy gums. What we might call the perfect tooth would resist indefinitely the same acid to which a tooth of opposite character would succumb in a few weeks.

Sixth. An occasional possible absence of an acid reaction in a cavity of decay is no indication that acid has not participated in the production of the cavity. Little or no value can be attached to tests of the saliva alone.

Seventh. Any general or special disorder or condition of the system which results in the withdrawal of lime salts from a tooth, or in a lowering of its density, or in a weakening of the chemical union between the organic and inorganic matter of the tooth, renders it more liable to decay.

Eighth. Strong acid and corroding substances brought but momentarily into the human mouth may give rise to lesions of the enamel at points where the ordinary agents alone could never have begun.

Ninth. All the microscopical appearances and characteristics of caries may be produced with the greatest exactness *out* of the mouth, simply by subjecting teeth to those acid mixtures which are constantly to be found *in* the mouth.

Tenth. The superficial layers of carious dentine undergo an almost if not absolutely complete decalcification, which decreases as we approach the normal dentine. The same is true of dentine decalcified in saliva and bread.

Eleventh. The destruction of the organic constituents follows (not precedes) the decalcification, and is evidently, for the most part, to be ascribed to the action of fungi.

Twelfth. The fungi found in the human mouth do not participate *directly* in the process of decalcification. The exact part which they perform in the production of an acid reaction requires further investigation.

Thirteenth. The fungi produce the most manifold anatomical changes in the softened dentine, resulting in the complete obliteration of the structure and final disappearance of the tissue in a mass of debris and fungi.

Fourteenth. The invasion of the micro-organisms is always preceded by the extraction of the lime salts.

Fifteenth. The destruction of the tissue remaining after decalcification is effected almost wholly by fungi alone.

Sixteenth. Inflammation can hardly be looked upon as a very important factor in caries of the teeth.

Seventeenth. Caries of the enamel is purely chemical, the decalcification resulting at once in the complete dissolution of the tissue.

Eighteenth. Caries of cement runs a course analogous to caries of dentine, a softening of the tissues by acids, and following this its destruction by fungi; a slight inflammatory action on the part of the living matter in the corpuscles is not to be excluded.

Dr. George Watt, in his "Chemical Essays" on "Caries of the Teeth," remarks: "It is evident that the acids do not all act alike on the teeth. Indeed, some exert no influence whatever on them, while others act with great energy on each and all of their constituents." In his notice of the agents which ordinarily act chemically on the teeth, producing caries and chemical abrasion, he accounts for the presence of certain acids in the mouth as follows: "Oxygen and nitrogen uniting in the mouth, in whatever proportions, *nitric acid* must be the ultimate result, as air and moisture, the only agents necessary in the transformation, are here always present. Mucus and particles of nitrogenous food lodged about the teeth undergo decomposition and yield nitrogen to the oxygen of the atmosphere or of the fluids of the mouth. Organic nitrogenous bodies contain hydrogen and oxygen as well as nitrogen, consequently by their decomposition these elements are all liberated. The mutual affinities of hydrogen and nitrogen take

precedence, and the result is the formation of ammonia, NH_3; ammonia exposed to the action of oxygen is always decomposed; oxide of nitrogen is formed, and nitric acid is the result." If buccal mucus as well as particles of nitrogenous food remain around, upon and between the teeth till decomposition is effected, the white variety of caries is produced. Nitric acid is also sometimes formed in the mouth by the agency of galvanic action, which may be generated by two metals placed in the mouth in close proximity to each other, and the fluids of the mouth acting on one of them. And if they are so situated that the mucous membrane forms a connecting conductor, by being in contact with both, a current may be established sufficient to decompose any of the binary compounds contained in these fluids. The liberated nitrogen, hydrogen, and oxygen will form ammonia and then nitric acid. But galvanic action in the mouth is more likely to develop hydrochloric than nitric acid. Some writers, however, contend that nitric acid is never formed in the mouth, for the reason that they have not found it present in a free state, because in such a state its effects would not be confined to carious tooth structure. The advocates of its presence in the mouth contend, on the other hand, that it combines atom by atom, as rapidly as it is generated, with the elements of the tooth structure, and that all conditions necessary for its formation exist in the mouth.

From the fact that putrefying animal substance has been found in carious cavities, and an alkaline reaction instead of an acid has been obtained from the tests of the carious matter of cavities, Dr. Miller also disputes the presence of nitric acid and its influence in producing "white decay."

The presence of *sulphuric acid* in the mouth is accounted for as follows: Albumen is a constituent of mucus, and is contained in many articles of food. Sulphur, if not a constituent of, is always united with albumen. Its ordinary presence in the mouth is therefore easily explained. Sulphur and oxygen unite directly, under various circumstances, as in the combustion of sulphur, but it is probable that the union here is effected by indirect means. Hydrosulphuric acid, or sulphuretted hydrogen, is one of the results of the putrefactive decomposition of albuminous substances. The oxygen of the atmosphere rapidly decomposes this acid by taking its hydrogen to form water. The sulphur is therefore set free, and being in its nascent state, its affinities are increased in energy, and it also unites with oxygen, forming sulphurous acid, SO_2, which in the presence of the saliva is rapidly converted into sulphuric acid, or SO_3. The quantity of sulphur, however, present in the

mouth at any one time is very minute, and a great proportion of this is exhaled by the breath before it has time to undergo decomposition. Sulphuric acid has a weaker affinity for the constituents of the tooth than some others, and the black decay resulting is not so common as some other varieties, and progresses less rapidly; and as from the nature of the chemical action the texture of the tooth is not so entirely broken up, the carbonized portion protects the parts beneath it, as the slow and prolonged action of this acid on the gelatinous portion of the tooth results in its carbonization, the carbonized gelatin being "animal charcoal." Sulphuric acid does not break down the texture of the tooth to the extent that some other acids do, because it cannot unite with or, under ordinary circumstances, decompose the principal earthy salt of which it is composed. Sulphuric acid is frequently administered as a medicine. The escharotic power of *hydrochloric acid* depends mainly on its affinity for water, which is very active, and on its ability to coagulate albumen. When concentrated, it dissolves animal tissues, but in this respect is far inferior to nitric acid; its chemical action is generally inferior to that of either nitric or sulphuric. When much diluted and mixed with dried mucous membrane, it dissolves coagulated albumen, fibrin, etc. Concerning the action of hydrochloric acid on the tooth: the carbonate of lime and the acid are mutually decomposed, the results being chloride of calcium, water, and carbonic acid. The carbonic acid escapes as a gas, and the chloride, being very soluble, is dissolved in the saliva and thus removed from the tooth. The phosphate of lime, though not decomposed by, is highly soluble in, hydrochloric acid. It is dissolved, and thus removed from the organic portion of the tooth. Hydrochloric acid is also administered as a medicine; it is also an ingredient of the gastric fluid, and is often present in abnormal quantities in the stomach, from which it is thrown into the mouth by eructation and vomiting. It may also be present in the saliva when the latter is in an abnormal condition, as it may originate in the decomposition of the soluble chlorides contained in the saliva and mucus. When the chlorine of these is liberated it takes hydrogen from the water of the saliva, and this acid is the result of the union. It is also sometimes directly furnished by the salivary glands, either as a secretion or an excretion; and it is usually found in the mouth when the mucous membrane is inflamed, as well as in patients who indulge in the excessive use of salted meats. Galvanic currents in the mouth always result in the formation of this acid.

What is known as the "septic theory" is explained as follows by Dr. C. S. Stockwell: "We will suppose an absolutely perfect tooth,

the enamel absolutely intact, and no defects whatever. The enamel in such a case forms a perfect protection against the micro-organisms. There are many places about the teeth, however, where food collects and remains undisturbed. Now the organisms of fermentation operate upon the food and saliva, and the result is an acid. This acid may erode the enamel in time, so that a portion of the organic tissue of the tooth becomes exposed; organisms may then act directly upon the fibrils or organic tissues; by absorbing the protoplasm they weaken its vitality or resisting force, disturb nutrition, set up inflammatory action, and the result is stasis and death of the organic tissue; after which the putrefactive and fermentative stage comes in, which disposes of both the organic and inorganic portions of the tooth. We, then, *first* have a *killing* of a portion of the organic tissue as a result of the action of organisms—a disease. Secondly, the disposal of the organic and inorganic by putrefactive and fermentative processes—caries." He also believes that the putrefactive and fermentative processes may be simultaneously going on, and that they are essentially, identically alike; and the result of one is alkali accompanied by an odor—putrefaction; and the other process results in an acid without the odor—fermentation; and that these processes have a common cause—organisms.

The generally accepted theory at the present time, of the cause of dental caries, is the "chemico-parasitic." According to this theory it progresses as follows: The enamel is first decalcified by the action of fermentation on some favorable point on the crown of the tooth, and the decalcification progressing involves the dentine. As soon as the enamel is removed the cavity affords lodgment for the micro-organisms, which at this stage of the affection can penetrate the dentinal tubuli, and the process of decalcification not only continues but is facilitated by the acid formed by these micro-organisms until the tooth-cartilage or organic portion of the structure alone remains, which at length undergoes putrefaction. Deposits of food upon the teeth are soon invaded by micro-organisms constantly found in the mouth. Dr. Miller has discovered no less than twenty-two different fungi in the human mouth, of which sixteen are capable of producing acids in substances prone to fermentation, which substances are decomposed and lactic acid, according to Dr. Miller's analysis, is generated. When the fluids of the mouth are acid, the acid formed by the micro-organisms acts in its full strength, whereas, if the oral fluid is normal in character the acid of the organisms is neutralized.

The foregoing theory of the cause of dental caries explains the *rationale* of the treatment at present adopted for arresting its progress. By the removal of the decomposed part and filling the cavity

with an indestructible material the contact of those agents upon the chemical action of which the disease depends is prevented and the further progress of the decay arrested.

PREVENTION OF CARIES.

It is an old adage, no less true than trite, that "an ounce of prevention is better than a pound of cure," and in the present instance it may be applied with its full force. Were more attention paid to the practical instruction thus conveyed, many of the diseases of the teeth might be avoided. Most of the remarks that might be made on this subject have been anticipated, consequently it will only be necessary to observe that if the teeth are well formed and well arranged all that will be required is to keep them clean; if any irregularity occurs it should be remedied by the means before described.

For cleansing the teeth, when they are in a sound condition and free from calcareous deposits, the gums healthy, and the secretions of the mouth normal in character, the regular and frequent use of pure water by means of a proper brush and waxed floss silk will, in most cases, be sufficient. But when the enamel is stained and discolored and the secretions of the mouth inclined to acidity, with a tendency to calcareous deposits, then the employment of a dentifrice is necessary.

Dentifrice—from *dens*, a tooth, and *frico*, *fricare*, to rub—is a medicinal preparation, in the form of a powder, for cleansing the teeth. An almost numberless variety of dentifrices are in use, and many of them highly injurious. In the preparation of an agent of this kind the object should be to obtain a compound pleasant to the taste, altogether free from acids and acrid substances, and soluble or insoluble, according to the nature of the case in which it is to be used—one capable of neutralizing and removing acrid and fermenting matters secreted between the teeth and also allaying irritation. A dentifrice, then, should be anti-acid and, moreover, a powder; and the more simple the preparation the better. A preparation composed of orris root, prepared chalk, and pure Castile or white Windsor soap, to which may be added very finely-powdered cuttle-fish bone or pumice-stone, for the removal of calcareous matter when there is a tendency to deposits of this nature, will answer every purpose. When the gums are in a healthy condition there is no use for such ingredients in a dentifrice as Peruvian bark or myrrh, and as for liquid dentifrices, they are of very little use, for the object in using the brush is friction, and as these liquid preparations are generally lubricating alkaline substances, they cause the brush to pass so easily

over the teeth as to render them almost useless. In many cases an unhealthy condition of the gums is owing to the irritation produced by local irritants, and their removal is all that is needed to restore them to health. Soap alone will not cleanse the teeth, for it prevents friction; and charcoal, notwithstanding its detergent and antiseptic properties, is injurious as a dentifrice, or as an ingredient of one, on account of its insinuating itself under the free margin of the gum and causing it to recede from the neck of the tooth, no matter how finely it may be pulverized. Either of the following dentifrices may be used:—

℞.	Prepared chalk, ...	℥ iv.
	Powdered orris root, ...	℥ iv.
	Powdered cinnamon, ...	ʒ iv.
	Sup. carb. of soda, ...	ʒ ss.
	White sugar, ...	℥ j
	Oil of lemon, ...	gtt. xv.
	Oil of rose, ...	gtt. ij.
℞.	Prepared chalk, ...	℥ ij.
	Powdered orris root, ...	℥ ij.
	Pumice stone, ...	℥ j.

Ingredients in both prescriptions to be thoroughly pulverized and well mixed.

The importance of keeping the teeth clean cannot be too strongly impressed upon the mind of every individual. Proper attention to the cleanliness of these organs contributes more to their health and preservation than is generally supposed. Against caries it is a most powerful prophylactic. "When the teeth," says Dr. L. S. Parmly, "are kept literally clean, no disease will ever be perceptible. Their structure will equally stand the summer's heat and winter's cold, the changes of climate, the variation of diet, and even the diseases to which the other parts of the body may be subject from constitutional causes."

The configuration and arrangement of some teeth is such, however, as to preclude the possibility of keeping them clean; but this should not deter any one from using the proper means, for if disease is not wholly prevented they will, at least, contribute very greatly to the preservation of the organs.

The subject of "food in relation to the teeth" has claimed the attention of eminent writers, many of whom are convinced that strict attention on the part of the mother to hygienic laws, from the time of conception, will influence for good the structural quality of the developing tooth-tissues of the child. As phosphate of lime is an important ingredient of the tooth-tissues, it is urged that the requisite

quantity of this lime salt should be supplied with the food, and that due attention to the laws of health in regard to exercise, rest, ventilation, bathing, etc., will cause the lime salt to be assimilated and properly appropriated in the formation and development of tooth-tissues. Many also believe that foods prepared by artificial means are very serviceable in supplying such elements as fail to be assimilated in the ordinary manner; hence the use during pregnancy and lactation of preparations of the syrup of the lactophosphate of lime, wheat phosphate, and such articles of diet as oatmeal, cracked wheat, etc., are recommended as being of great benefit. No doubt the amount of phosphate to be used by the system will depend, in a great measure, upon the digestion.

PART THIRD.

DENTAL SURGERY.

Besides the operations of General Surgery which are performed upon the mouth, in common with other parts of the body, Dental Science gives specific directions for those operations of Special Surgery demanded in the—

1. Correction of Irregularities in the Arrangement of the Teeth.
2. Treatment of Dental Caries.
3. Extraction of Teeth.
4. The Use of Anæsthetic Agents.
5. Dislocation and Fracture of the Jaw.
6. Diseases of the Maxillary Sinus or Antrum.
7. Caries of the Maxillary Bones.

CHAPTER I.

IRREGULARITY OF THE TEETH—ORTHODONTIA.

METHOD *of Directing Second Dentition.*—To properly direct second dentition a knowledge of the relative position of the permanent and temporary teeth at a period soon after the appearance of the first teeth of the permanent set is necessary. Fig. 142 represents the jaws of a child between six and seven years of age, all of the temporary teeth being in position and the six-year molars erupting.

FIG. 142.

The developing crowns of the permanent teeth occupy a higher place than the temporary teeth, and the superior central incisors have a more outward inclination, on account of their size and the increased width of the arch they are to occupy when erupted. The crowns and a small portion only of the roots of these teeth are completed, and they are placed directly under and in contact with the floor of the nares. The superior lateral incisors are not so far advanced in their development as the central incisors, and their crowns are situated beneath the angle of the nares and back of the roots of the temporary laterals and canines.

The canines are situated on a higher plane than either the central or lateral incisors, not more than one-fourth of an inch below the infra-orbital canals and along the sides of the outer walls of the nares, with their crowns about completed. The crowns of the first and second superior bicuspids are situated on the same plane as the

lateral incisors, being embraced by the roots of the first and second temporary molars, and are but partly developed. The crowns of the first permanent molars of both jaws have erupted and are about antagonizing with each other, but their roots are only one-half formed. The crowns of the permanent second molars are but partly developed, and are situated above and posterior to the roots of the first permanent molars, their grinding surfaces having a direction downward and slightly backward toward the lower portion of the external pterygoid processes. The dentes sapientiæ of the upper jaw are represented by small crypts only, in a higher plane in the maxillary tuberosities.

The inferior permanent central incisors are situated directly behind the roots of the temporary incisors, and have their crowns completed with about one-fourth of their roots. The roots of the permanent lateral incisors are not so far developed and are situated somewhat back of the crowns of the permanent central incisors and canines. The permanent central and lateral incisors, as do all of the inferior teeth, occupy a vertical position in the jaws, on account of the inferior dental arch being smaller than the superior. The inferior permanent canines occupy a lower plane than the incisors, and their partly developed roots extend very near to the under surface of the bone of the jaw. The position and stage of development of the inferior permanent bicuspids and first molars are about the same as those of the corresponding teeth of the upper jaw.

The developing crowns of the permanent second molars occupy a higher plane than that of the bicuspids, and their grinding surfaces have a direction upward and forward. The inferior dentes sapientiæ are represented by small crypts only, in the coronoid processes.

There is nothing more destructive to the beauty, health, and durability of the teeth, and no disturbance more easily prevented, than irregularity of their arrangement. Also, in proportion to the deviation of these organs from their proper position in the alveolar arch, are the features of the face and the expression of the countenance injured. It also increases the susceptibility of the gums and alveolo-dental membrane to morbid impressions.

It is important, therefore, that the mouth, during second dentition, should be properly cared for; and so thoroughly convinced is the author of this, that he does not hesitate to say that if timely precautions were used there would not be one decayed tooth where there are now a dozen.

Much harm, it is true, may be done by improper meddling with the teeth during this period, but this, so far from inducing a total neglect, should only make those having the care of children more

solicitous in securing the services of scientific, accomplished practitioners.

For the judicious management of second dentition, much judgment and a correct knowledge of the normal periods of the eruption of the several classes of teeth are required. All unnecessary interference with these organs at this early period of life should certainly be avoided, as it will only tend to mar the perfection at which nature ever aims. The legitimate duty of the physician being, as Mr. Bell correctly observes, "the regulation of the natural functions when deranged," he should never anticipate the removal by nature of the temporary teeth unless their extraction is called for by some pressing emergency, such as a deviation of the permanent ones from their proper place, alveolar abscess, or exfoliation of the alveolar processes.

The mouth should be frequently examined from the time the shedding of the deciduous teeth commences until the completion of second dentition; and when the growth of the permanent teeth so far outstrips the destruction of the roots of the temporary that the former are caused to take an improper direction, such of the latter as have occasioned the obstruction should be immediately removed. In the dentition of the upper front teeth this should never be neglected; for when they come out behind the temporaries, as they most frequently do, and are permitted to advance so far as to fall on the inside of the lower incisors, a permanent obstacle is offered to their subsequent proper adjustment.

When a wrong direction has been given to the growth of the lower front teeth, they are rarely prevented from acquiring their proper arrangement by an obstruction of this sort. They should not, however, on this account be permitted to occupy an erroneous position too long; for the evil will be found easier of correction while recent than after it has continued for a considerable length of time. The irregularity should be immediately removed.

The permanent central incisors of the upper jaw being larger than the temporaries of the same class, it might, therefore, be supposed that the aperture formed by the removal of the one would not be sufficient for the admission of the other without an increase in the size of this part of the maxillary arch. It should be recollected, however, that by the time these teeth usually emerge from the gums, the crowns of the temporary lateral incisors are so much loosened by the partial destruction of their roots as to yield sufficiently to the pressure of the former to permit them to take their proper position within the dental circle. When this does not happen, the temporary laterals should be extracted.

Under similar circumstances the same course should be pursued with the permanent lateral incisors and the temporary cuspids, and also with the permanent cuspids and the first bicuspids.

But from the fact that the bicuspids are erupted before the permanent cuspids, the premature extraction of the temporary cuspids is often the cause of the projection of one or more of the front teeth; sometimes to such a degree as to produce considerable deformity.

The removal of the temporary cuspids should therefore be avoided when there is reason to believe that the growth of the jaw will provide sufficient space for a deviating permanent lateral incisor to take a proper position within the dental arch.

The bicuspids being situated between the roots of the temporary molars are seldom caused to take an improper direction in their growth. Nor are they often prevented from coming out in their proper place for want of room.

In the management of second dentition much will depend on the experience and judgment of the practitioner. If he be properly informed upon the subject, and gives to it the necessary care and attention, the mouth will in most instances be furnished with a healthful, well arranged, and beautiful set of teeth. At this time "an opportunity," says Mr. Fox, "presents itself for effecting this desirable object" (the prevention of irregularity), "but everything depends upon a correct knowledge of the time when a tooth requires to be extracted, and also of the particular tooth, for often more injury is occasioned by the removal of a tooth too early than if it be left a little too long; because a new tooth which has too much room long before it is required will sometimes take a direction more difficult to alter than a slight irregularity occasioned by an obstruction of short duration."

The temporary teeth by remaining too long are likely to affect the arrangement, and consequently the health, of the permanent teeth, and they should be extracted, because, in that case, their presence is a greater evil than any that would be occasioned by their removal. As a general rule, they should be suffered to remain until their presence is likely to injure the permanent teeth and their contiguous parts.

When the permanent teeth are crowded, the lateral pressure is frequently so great as to fracture the enamel. If this cannot be prevented in any other way, one on each side should be extracted. It is better to sacrifice two than permanently to endanger the health of the whole.

The file or revolving discs and points upon the dental engine should never be used with a view to remedy irregularity; the extraction of two teeth, one on each side of the jaw, however small

the space required to be gained may be, is far preferable. The second bicuspids, *cæteris paribus*, should always be removed rather than the first, but sometimes the extraction of the first becomes necessary.

By the removal of the teeth ample room will be gained for the arrangement of all the remaining ones, and the injury resulting from a crowded condition of the organs prevented.

The author does not, however, wish to be understood as conveying the idea that filing the teeth necessarily causes them to decay, for, when the file is used for any other purpose than to gain room, the apertures may be made large enough to prevent the approximation of the organs, and thus the bad effects resulting from the operation will be prevented.

The extraction of the root of a superior front tooth, a central incisor, for example, when the crown has been greatly disfigured or wholly destroyed by mechanical violence, may cause the superior front teeth to fall behind the inferior teeth. Should such a deformity not occur, it frequently happens that an unsightly space is left, too small for the insertion of an artificial tooth to correspond in size with the adjoining natural ones.

To avoid such results the root should be allowed to remain and the proper treatment instituted to subdue the inflammation, the pulp removed when exposed, and the root filled to the apex with gold or other suitable material. By pursuing such a course the root is retained until such a time as its removal will not affect the adjoining teeth. In some cases the portion of the crown destroyed may be restored with gold, or an artificial crown inserted on a pivot.

When the deciduous canines are extracted on the approach of the permanent lateral incisors, the first bicuspids will move forward and occupy the space necessary for the reception of the permanent canines, which may erupt over the laterals, and by their pressure cause these latter teeth to shut within the lower teeth.

Fig. 143 illustrates the mischief attending the premature extraction of the deciduous canines.

Nature, when permitted to proceed with her work without interruption, is able to perform her operations in a perfect and harmonious manner. But the functional operations of all the parts of the body are liable to be disturbed, from an almost innumerable number and variety of causes, and impairment of one organ often gives rise to derangement of the whole organism, for the relief of which the interposition of art not unfrequently becomes necessary, and it is fortunate for

Fig. 143.

the well-being of man that it can in so many instances be applied with success.

In sound and healthy constitutions the services of the dentist are seldom required to assist or direct second dentition. In remarking upon this subject, Dr. Koecker observes, "that the children for whom the assistance of the dentist is most frequently sought are those who are in delicate, or at least imperfect, constitutional health; in whom the state not only of the temporary teeth, but of the permanent also, is to be considered, and where both are found to be diseased the future health and regularity of the latter require the greatest consideration of the surgeon.

"Irregularity of the teeth is one of their chief predisposing causes of disease, and never fails, even in the most healthy constitutions, to destroy, sooner or later, the strongest and best set of teeth unless properly attended to. It is thus not only a most powerful cause of destruction to the health and beauty of the teeth, but also to the regularity and pleasing symmetery of the features of the face; always producing, though slowly and gradually, some irregularity, and not unfrequently the most surprising and disgusting appearance."

Though nature is generally able to accomplish the task assigned her, yet there are times when she requires aid, and it is then, and then only, that the services of the dentist are needed. Therefore, whilst on the one hand we should guard against any uncalled-for interference, we should on the other always be ready to give such assistance as the nature of the disturbance presented to our notice may require.

The progress of caries in the temporary teeth is very rapid, as a general rule, owing to the large proportion of organic matter compared with the inorganic. Alveolar abscess is, therefore, a common result of the loss of vitality, and the absorption of the alveolar processes from such a cause may expose the apex of the root of one or more temporary teeth.

In the case of the necrosed roots of the superior incisors presenting such a condition, and it is necessary that such teeth should be preserved in order to prevent an irregular arrangement of the succeeding permanent ones, which is very prone to occur from the premature loss of the temporary teeth, the exposed ends of the roots of the necrosed temporary teeth may be excised and carefully rounded off with the file or corundum point. By such a method the necrosed teeth may be retained in the mouth until the period of shedding has arrived, and the space necessary for the reception of the corresponding permanent teeth be preserved.

The eruption of the permanent teeth begins before any of the

temporary teeth are shed, the first of the permanent teeth to appear being the sixth-year molars, between the five and a half and six and a half years. These teeth are often mistaken for temporary teeth, and being prone to decay, on account of defective structure and the early period of their eruption, they are frequently lost early in life. But as the sixth-year molars perform an important part in the preservation of the integrity of the arch, their retention is desirable if possible. Cases, however, occur where they cannot be permanently preserved, when every effort should be made to preserve them up to a certain period, namely, until the twelfth-year molars are about to erupt, or until a period between the tenth and twelfth years. If the sixth-year molars are lost earlier than the period

Fig. 144.

Sixth-Year Molar.

named, the adjoining teeth will close up and cause irregularity when the other teeth appear. On the other hand, if the sixth-year molars are lost later than the time named, the space they occupied is never compactly closed, and the adjacent teeth will incline toward the vacant space, and the continued occlusion in mastication will cause them to tip over to such a degree as to result in a decided impairment of the occlusion. Such irregular teeth may also become painful and loose, on account of the recession of the gums and the absorption of the alveolar processes, and even the adjoining teeth may suffer in a similar manner.

Fig. 144 represents an adult lower jaw, side view.

Irregularity of Arrangement of the Teeth.—The causes of the various forms of irregularity of the teeth are divided into *accidental*—those occurring after the eruption of the teeth, and *congenital*—those occurring prior to their eruption.

The accidental forms of irregularity are most commonly caused by the presence of temporary teeth beyond the proper time of shedding, owing to the process of absorption of their roots not being commensurate with the development of the permanent teeth, or to the presence of necrosed roots of temporary teeth which are not absorbed. The congenital forms of irregularity are generally caused by a want of development of the jaws commensurate with the size of the teeth. In some rare cases the excessive development of the maxillæ may result in abnormal spaces between the teeth.

The temporary teeth seldom deviate from their proper place in the alveolar arch; but irregularity of arrangement is of frequent occurrence in the permanent teeth, especially the cuspids and incisors. The first and second molars are seldom irregular, for, like the teeth of first dentition, they rarely encounter obstruction in their growth and eruption. The sixth-year molars being the first of the permanent set to appear, the ten anterior teeth are limited to that part of the arch occupied by the ten temporary teeth; if this space is too small, irregularity must of necessity ensue.

The dentes sapientiæ are sometimes irregularly erupted, in consequence of a want of correspondence between the development of the tooth and the growth of the maxilla. The tooth in such cases takes usually the direction of least resistance, the crown presenting more or less obliquely forward, backward, outward, or inward. Of these four positions the first and fourth are found usually in the lower jaw; the second and third are most common in the upper jaw.

When a biscupid is forced from its proper place it turns inward toward the tongue or outward toward the cheek, accordingly as it is in the upper or lower jaw; or it may be so turned in its cavity by the occlusion of the teeth in the opposite jaw, the loss of an adjoining tooth giving the necessary space, as to present one of its proximate surfaces toward the cheek. The cuspids, when prevented from coming out in their proper place, make their appearance either before or behind the other teeth. When they come out anteriorly, which they do more frequently than posteriorly, they often become a source of annoyance to the upper lip, excoriating and sometimes ulcerating the mucous membrane.

The incisors of the upper jaw present a greater variety of abnor-

mal arrangement than any of the other teeth. The centrals come out sometimes before and sometimes behind the arch; at other times their median sides are turned either directly or obliquely forward toward the lip. The laterals sometimes appear half an inch behind the arch, looking toward the roof of the mouth; at other times they come out in front of the arch, and at other times, again, they are turned obliquely or transversely across it.

When any of the upper incisors are transversely inclined toward the interior of the mouth, the lower teeth at each occlusion of the jaws shut before them and become an obstacle to their adjustment. This form of irregularity often interferes with the lateral motion of the jaw.

The lower incisors sometimes shut in this manner even when there is no inward deviation of the upper teeth. In this case the irregularity is owing to preternatural elongation of the lower jaw, which arises more frequently from some fault of dentition than from any congenital defect in the jaw itself.

Sometimes the superior maxillary arch is so much contracted, and the front teeth in consequence so prominent, that the upper lip is prevented from covering them. Cases of this kind, however, are rarely met with, but when they do occur it occasions much deformity of the face and forms a species of irregularity very difficult to correct. From the same cause the lateral incisors are sometimes forced from the arch and appear behind the centrals and cuspids, the dental circle being filled with the other teeth.

Fig. 145.

An abnormal prominence of the superior incisors may be either congenital or accidental, and when of the former origin it is almost invariably accompanied with a contracted arch, especially between the bicuspids of the right and left sides of the mouth, the incisors occupying a V-shaped position (Fig. 145).

When this form of irregularity has an accidental origin, it is

generally caused by a pernicious habit of thumb, tongue, or artificial nipple-sucking.*

Figs. 146 and 147 represent the form of irregularity caused by thumb-sucking.

An unusual prominence of the superior incisors, attended with a diminution of space between the bicuspids and an abnormally high vaulting of the palate, has been thought by some to be very common to congenital idiots. But Drs. N. W. Kingsley and J. W. White, who examined the inmates of some large institutions for the care of the feeble-minded, found that such a defect is not an invariable rule, as only a small percentage of pronounced irregularity in form of the jaws or arrangement of the teeth, and that generally associated with the lowest type of idiocy, was common to such a class of persons.

Fig. 146.

Fig. 147.

Tonsillitis has also been named by Mr Tomes as a cause for a contracted arch between the opposite bicuspids, the labored breathing from the filling up of the fauces by the enlarged tonsils, with the mouth open, causing increased compression of the cheeks over the lateral parts of the mouth, while the median portion escapes the controlling pressure which would be exercised when the mouth is closed.

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*Such a habit as thumb-sucking may be prevented by the application of some bitter substance, such as aloes, to the thumb, tying the arms close to the body at night, or the wearing of coarse, heavy gloves.

Dr. Kingsley is of the opinion that the V shaped arch is nearly always of congenital origin—that is, an inherited tendency, while the broad or rounded form of arch is often due to mechanical causes.

Inflammation of the throat early in life in children of a strumous diathesis will not only produce deformity of these parts, but irregularity of arrangement of the teeth, by causing tension of the muscles, which has the effect of contracting the oro-naso-pharyngeal space by pressing the lateral portions of the walls inward.

The retention in the jaw of permanent teeth is also a cause of irregularity, as in some cases bicuspids and molars may not erupt sufficiently to meet the opposing teeth.

There are many other deviations in the arrangement of the incisors. Mr. Fox mentions one that was caused by the presence of two supernumerary teeth of a conical form, situated partly behind and partly between the central incisors, which in consequence were thrown forward, while the laterals were placed in a line with the supernumeraries. The central incisors, though half an inch apart, formed one row, and the laterals and supernumeraries another. Mr. Fox says he has seen three cases of this kind. This description of irregularity is rarely met with.

M. Delabarre says that cases of transposition of the germs of the teeth occasionally occur, so that a lateral incisor takes the place of a central, and a central the place of a lateral. A similar transposition of a cuspid and lateral incisor is, also, sometimes seen. Two cases of this sort have fallen under the observation of the author.

The incisors of the lower jaw, being smaller than those of the upper and in other respects less conspicuous, do not so plainly show an irregularity in their arrangement, nor is the appearance of an individual so much affected by it. Still it should be guarded against; for such deviation, whether in the upper or lower jaw, may prove injurious to the health of the teeth and the beauty of the mouth. The growth of the inferior permanent incisors is sometimes more rapid than the destruction of the roots of the corresponding temporaries. In this case the former emerge from the gum behind the latter, and sometimes so far back as greatly to annoy the tongue and interfere with enunciation. At other times the permanent centrals are prevented from assuming their proper place, because the space left for them by the temporaries is not sufficient. The irregularity in the former of these two cases is greater than in the latter. The same causes in like manner affect the laterals.

M. Delabarre mentions a defect in the natural conformation of the

jaws, by which the upper temporary incisors on one side of the median line are thrown on the outside of the lower teeth, while the corresponding teeth on the other side of the same line fall within. The same arrangement, he says, may be expected, unless previously remedied, in the permanent teeth. The author has met with but two cases of this sort, and the subjects of these he did not see until after they had reached maturity.

Referring to an ingrafted tendency in all living matter to reproduce itself, Dr. Kingsley remarks: "I am of the opinion that such deformities, even when transmitted for generations, may have the tendency stamped out by being corrected immediately on their development; that is, before the deformity has made its fixed impression upon the individual."

Mr. Mummery is of the opinion that a large amount of dental disease is originated by overtaxing the brain action of children, and Dr. Kingsley remarks that "the next generation will see more abnormality in dental development and an increase of nervous and cerebral diseases, and that the two are correlated and spring from the same cause."

Treatment of Irregularity.—Orthodontia, or the treatment of irregularity, should accord with the indications of nature. When the irregularity is neither great nor complicated, and its causes are removed before the nineteenth or twentieth year, the teeth, without the aid of art, will in many cases assume their proper position. When, however, the efforts of the economy are unavailing, recourse should be had to the dentist, who can, in most instances, bring the deviating organs to their proper position in the arch. The general rule is, that as soon after the eruption of a tooth as it becomes certain that it will assume an irregular position, interference is justifiable, as every year not only increases the difficulties, but impairs the stability of the dental organs. Teeth incline to return to their place on the removal of the cause of irregularity. They may be also made to change position under the influence of pressure. The pressure must be constant; it must be sufficient to cause motion, yet not so great as to set up destructive inflammation; lastly, it must be continued until the teeth can be kept in place by antagonism with the opposing teeth; or in case there is no such antagonism, a retaining appliance must be worn more or less constantly for a year, or even longer. The regulating appliance should be as simple in its construction as is possible to accomplish the purpose, so that both time and labor may be saved and the patient be able to attend to its removal and adjustment when it becomes necessary to cleanse it; this should frequently be done.

Teeth artificially regulated change position chiefly, if not entirely, by the double process of absorption from one side of the socket, followed by the slower process of ossific deposit on the opposite side. It is therefore essential to success that the tooth be retained in its new position, either by the other teeth or by mechanical appliance, until such deposit is formed. Many cases fail from a want of persistence on the part of patient or dentist.

How far and in what direction a tooth may be removed will depend partly upon the position of the apex of the root, partly upon the antagonism of the opposing teeth.

Cuspids growing out far upon the alveolar arch will usually be found to have short and curved roots. The attempt to move them might cause the curved apex to pierce the alveolus. Even when not curved, the root is short, and the regulated tooth will not possess that durability which is characteristic of the cuspids. It should always be borne in mind that in regulating the teeth the crown is the movable point, whilst the apex of the root is the fixed point, and must determine in great degree the extent and direction of motion.

Again, the natural or artificial movement of bicuspids backward to make room for front teeth may be aided or hindered by the opposing teeth. An upper bicuspid, for instance, once carried back, so that the posterior slope of the lower bicuspid strikes it, will retain its position or may be thrown even further back.

Upper incisors striking inside the lower, or lower incisors unnaturally prominent, may be regulated, and the opposing teeth will tend to keep them in their corrected position. But it will require long and patient use of the regulating apparatus to keep in place upper incisors which project outward, or lower incisors inclining inward.

In deciding upon the removal or extraction of an irregular tooth, it should not be forgotten that a tooth moved by mechanical appliance, especially if the change in position is considerable, will not prove as durable as if no movement had been necessary. Hence it may sometimes be advisable to extract irregular cuspids in cases where their correction requires much change in their position and that of the bicuspids, and the arch is completely and regularly filled by the remaining teeth.

In a case presented to the late Prof. Austen the superior arch was perfectly regular and closely filled, but both cuspids had come out above the arch. The cuspid roots were normal, and it seemed practicable to bring these teeth down into the places of the first bicuspids. But the four bicuspids were sound, and the first bicuspids gave very

much the appearance of the natural arrangement. Hence, as in point of expression there would be no great gain and in point of durability a probable loss, it was not thought advisable to subject the patient to the tedious annoyance of regulation.

In describing the treatment of irregularity we shall notice the means by which some of its principal varieties may be remedied; otherwise, the application of the principles of treatment would not be well understood, since it must be varied to suit each individual case.

As a general rule, the sooner irregularity in the arrangement of the teeth is remedied the better; for the longer a tooth is allowed to occupy a wrong position, the more difficult will be its adjustment. The position of a tooth may sometimes be altered after the eighteenth, twentieth, or even the thirtieth year; but it is better not to delay the application of the proper means until so late a period. A change of this kind may be much more easily effected before the several parts of the osseous system have reached their full development, and while the formative process is in vigorous operation, than at a later period of life. The age of the subject, therefore, should always govern the practitioner in forming an opinion as to the practicability of correcting irregularity. Previously to the twentieth year the worst varieties of irregularity may in most cases be successfully treated.

The first thing claiming attention in the treatment is the removal of its causes. Whenever, therefore, the presence of any of the temporary teeth has given a false direction to one or more of the permanent, they should, as a general rule, be extracted, and the deviating teeth pressed several times a day with the finger in the direction they are to be moved. This, if the irregularity has been occasioned by the presence of a deciduous tooth, will generally be all that is required.

But when it is the result of narrowness of the jaw, either congenital or acquired, a permanent tooth on either side should be removed to make room for such as are improperly situated. All the teeth being sound and well formed, the second bicuspids are the teeth which should be extracted; but if, as is often the case, the first permanent molars are so much decayed as to render their preservation impracticable, or, at least, doubtful, these teeth should be removed in their stead. After the removal of the second bicuspids, the first, usually, very soon fall back into the places which they occupied, and furnish ample room for the cuspids and incisors. But if they fail to do this, they may be gradually forced back by inserting wedges of wood or rubber between them and the cuspids,

or by means of a ligature of silk or rubber securely fastened to the first molar on each side, or by other proper appliances. These should be renewed every day until the desired result is produced.

The most frequent kind of irregularity resulting from narrowness of the jaw is the prominence of the cuspids. These teeth, with the exception of the second and third molars, are the last of the teeth of second dentition to be erupted, consequently they are more liable to be forced out of the arch than any others, especially when it is so much contracted as to be almost entirely filled before they make their appearance. The common practice in such cases was to remove the projecting teeth. But as the cuspids contribute more than any of the other teeth, except the incisors, to the beauty of the mouth, and can in almost every case be brought to their proper place, the practice is injudicious. Instead of removing these, a biscupid should be extracted from each side. When the space between the lateral incisor and the biscupid is equal to one-half the width of the crown of the cuspid the second bicuspid should be removed, but when it is less, the first should be taken out, because, although the crown of the latter may be carried far enough back after the removal of the former to admit the crown of the cuspid between it and the lateral incisor, the root of this tooth will remain in front and partly across the root of the first bicuspid, leaving a more or less prominent vertical ridge on the anterior part of the alveolar border, which, to some extent at least, acts as an irritant to the gums and periosteum.

As the incisors of the upper jaw are more conspicuous than those of the lower, and when well arranged contribute more to the beauty of the mouth, their preservation and regularity are of greater relative importance. Hence, the removal of a lateral incisor, when it is situated behind the dental arch, as is often done with a view to remedy the deformity produced by false position, is a practice which cannot be too strongly deprecated, provided sufficient space can be made for it between the cuspid and central incisor by the removal of a biscupid from each side of the jaw.

Dr. Kingsley remarks that "cases are of frequent occurrence which show that a pair of any of the teeth in the mouth may be removed to correct an irregularity, excepting the canines of both jaws and the superior central incisors." "It would be an inconceivable case which would justify the extraction of the superior central incisors; but the upper lateral incisors and any pair of the lower incisors may be removed, in certain cases, without any serious detri-

ment to the appearance of the mouth." "It is not necessary to the contour, symmetry, or harmony of the features that every one of the masticating organs should be retained in the mouth." "The *articulation* of masticating organs is of much more importance than their number, and a limited number of grinding teeth fitting closely on occlusion will be of far greater benefit to the individual than a mouthful of teeth with the articulation disturbed." "It is a disputed point as to which of the teeth behind the six front teeth can be best spared from the mouth." "If the sixth-year molars are badly decayed their removal would be indicated. If they were sound, and also the bicuspids, there might be no greater reason for their removal than either of the bicuspids. In fact, sound molars in the jaw are of more value as masticating organs than equally sound bicuspids." The same writer is also of the opinion that extraction of any teeth from a V-shaped jaw before it is widened would be likely to prove bad practice.

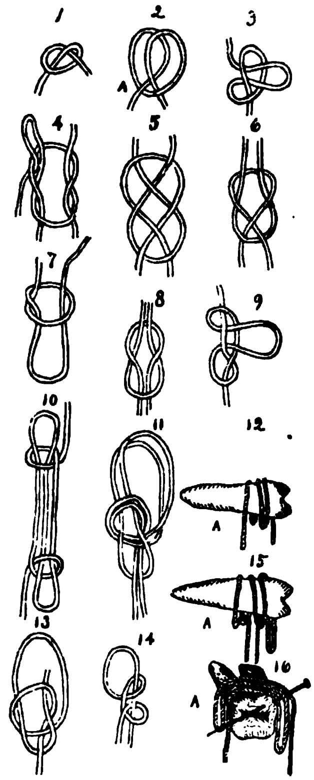
Many different forms of appliances are necessary in correcting an irregular arrangement of the teeth, as almost every case presents its own peculiarities. It is therefore not only impossible to describe every form of irregularity to which the teeth are subject, but also the forms of appliances necessary. The attention of the reader will, therefore, be directed to the treatment of the most common forms and the necessary appliances for their correction, modifications of which can be constructed according to the peculiarities presenting themselves. The most simple appliances for correcting irregularity consist of rings cut from rubber tubing and silk or rubber ligatures, which have their uses in the management of some of the easily manipulated cases. The value of such simple appliances, however, depends upon the skill exercised in applying and securing them. A simple band or ring cut from rubber tubing, and prevented from slipping up to and injuring the gum by means of waxed floss-silk tightly tied about the necks of the teeth, will answer for drawing two teeth, incisors for example, together, between which there is an unsightly space. A similar ring may be employed for correcting an irregular front tooth which projects beyond the arch.

The following figures represent some of the most useful knots for applying silk ligatures:—

Fig. 148 represents 13 forms of the most useful knots: 1, thumb-knot; 2 (12, 15, 16), various stages of the clove-hitch; 3, drag-rope, or lever-hitch; 4, draw-knot; 5, garrick bend; 6, common or sheet-bend; 7, running-knot; 9, men's harness-hitch; 10, sheep-shank; 11, double bowline-knot; 12, first stage of clove-hitch; 13, single bowline-knot; 14, half-bitch; 15, second stage of clove-hitch.

In describing the treatment of irregularity we shall commence with an incisor occupying an oblique or transverse position across the alveolar ridge; so that the cutting edge of the tooth instead of being in a line with the arch forms an angle with it of from forty to ninety degrees. This variety of deviation is rarely met with in both centrals, but often occurs with one. Some dentists have recommended in cases of this kind, when the space between the adjoining central and lateral incisor is equal to the width of the deviating tooth, to turn the latter in its socket with a pair of forceps, or to extract and immediately replace it in its proper position. It is scarcely necessary to say that if a tooth is turned in its socket, without great care is exercised and the operation gradually performed, the vessels and nerves from which it derives nourishment and vitality are strangulated; hence, though its connection with the alveolus may be partially re-established, it will be liable to act as a morbid irritant and be subject to inflammation from comparatively slight causes.

FIG. 148.



The tooth, however, may be brought to its proper position, without incurring the risk of injury, by accurately fitting a gold ring or band with knobs on the labial and palatine sides; to each of these a ligature should be attached. Thus fastened to the ring, each end should be carried back, one on either side, in front and behind the arch and secured to the bicuspids, as represented in Fig. 149, so as to act constantly upon the irregular tooth. The ligatures should be renewed from day to day until the tooth assumes its proper position. Should the space not be sufficient to permit the use of the band the method practiced by Mr. Tomes is shown in Fig. 150. A plate is fitted to the inside of the arch and a band carried in front and soldered to projections from the plate, which pass between the bicuspids. On each side of the irregular tooth a metallic dovetail is fastened and pieces of compressed wood inserted into them. The swelling of the wood grad-

ually turns the tooth. In a few days the metal sockets will require to be changed in position, and in a few weeks the tooth may be thus brought nearly or quite to its natural place.

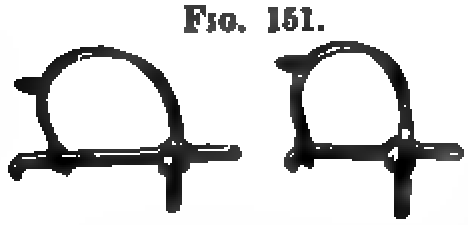
If the space permits these two methods may be advantageously combined. Use the plate as in Fig. 150, with the inner dovetail, but for the long outside band substitute the band (Fig. 149) around the tooth, with a loop on the median side; from this pass an elastic ligature to a hook soldered on the plate. The tooth is turned on its axis by the combined pull of the ligature and thrust of the wood.

FIG. 149. FIG 150.

For turning or twisting a tooth upon its axis, Dr. J. F. Flagg recommends the clove-hitch, Fig. 148[2], over which the ends of the ligatures are passed and then tied tightly with a surgeon's knot, which holds so firmly to the tooth that it will not slip; the ends are then carried to a rubber ring attached to a neighboring tooth, and by its elasticity keeps up a constant torsion force.

For rotating a single tooth as well as drawing out teeth that incline within the arch, the screws represented in Fig. 151 and designed by Dr. Farrar will be found as useful as any other means.

FIG. 151.



Before attempting to turn the deviating organ it should be ascertained if the aperture between the adjoining teeth is sufficient to admit of the operation. If not it should be increased by the extraction of a bicuspid from each side of the jaw and moving the teeth in front of them backward until sufficient room is obtained. The time required to do this will vary from three to eight or ten weeks, depending upon the number of teeth to be acted on and the age of the patient. A sufficient space may sometimes be gained by pressing outward the adjoining teeth in cases where they fall within the normal curve of the arch.

This may be done by the use of the "Coffin Split Plate," or by the "Norton-Talbot Regulating Springs," both of which appliances are described further on.

Figs. 152, 153, and 154 represent favorite devices of Dr. J. N. Farrar for rotating teeth, the simplicity of which requires no further

FIG. 152.

FIG. 153.

FIG. 154.

explanation except that it is constructed entirely of gold or platinum, and bound upon the tooth to be rotated by a slip-noose as thin as writing paper and about one-twelfth to one-fifteenth of an inch wide, which is tightened by means of a nut screwed against a small strip of plate resting against other teeth.

FIG. 155.

FIG. 156.

Irregular and protruding front teeth may be partially rotated and drawn into position by a very simple, but at the same time ingenious appliance devised by Dr. S. H. Guilford. Figs. 155, 156, 157, 158, and 159 represent two cases of the kind referred to and Dr. Guilford's appliance. According to Dr. Guilford's description, this appli-

ance is made on a model of the teeth, and is constructed as follows: "A piece of gold backing cut an eighth of an inch wide, and of sufficient length to extend along and a trifle beyond the palatal surfaces of the centrals, is bent to conform as closely as possible to the lingual surfaces of these teeth, and forward so as to slightly clasp the disto-palatal angles as shown in *a*, Fig. 157. To this are soldered two strips cut from upper plate scrap, a little narrower than the first piece, and bent in the form of *b* and *c*, Fig. 157, respectively, which are sufficiently long to extend slightly over the anterior and posterior surfaces of the teeth. After being properly shaped to fit the model, their backs are soldered together, and, in turn, soldered to the part (*a*), as shown in Fig. 157. The only thing then to be done is to reduce with a file the thickness of the part *b*, *c*, which passes between the teeth, Fig. 158. Before applying such a fixture, it may be necessary to place a piece of wood between the teeth for a few hours, to separate them sufficiently to admit the appliance. The labial part of the apparatus should rest against the teeth just at or slightly above the most prominent part of their convexity, while the lingual portion should be near the gum (not quite touching it), and the slightly curved ends of this part will catch just above the little nodule usually found on the disto-palatal angle near the gum. When thus secured it cannot easily be displaced by the action of the lip or tongue. Bend the long palatal arms slightly toward the short labial ones daily, and spring it back into position on the teeth. The elasticity of the gold stiffened by the solder will do the work. To guard against its accidental loosening tie it to the tooth with a thread."

Fig. 157.

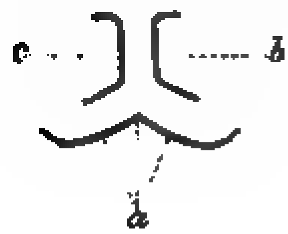


Fig. 158.

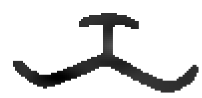


Fig. 159.

Fig. 160 represents an appliance designed by Dr. Kingsley for twisting the central incisors. After the arch was expanded, as it was a case of contracted arch, a vulcanite plate was required to retain the teeth in their spread condition, and its presence was made available for attachments for elastic ligatures. A small hook of gold

wire was inserted opposite the canine teeth, and a little staple or loop of the same wire at the apex of the plate between the centrals. Previous to insertion a ring of rubber cut from tubing was caught over one hook, passed through the loop at the apex and caught on to the other hook. The plate was then introduced into the mouth and the elastic band drawn over each lateral incisor, as seen in the figure. The tendency of the elastic band to contract in a straight line operated only on the inverted corners of the centrals, and by this means the centrals were turned into their proper positions.

FIG. 160.

Figs. 161 and 162 represent a case of irregularity before and after treatment, where the overlapping central incisors were turned and a deviating lateral incisor forced outward by the appliances just described.

The operation known as "*torsion*," which has been recommended by Mr. Tomes, consists in forcibly turning a tooth in its cavity by grasping it near its neck with a pair of forceps, the beaks of which are guarded with chamois-skin or other substances, to prevent injury. Where the deviating tooth, such as an incisor, requires but one-fourth of a turn or twist, or less, this is accomplished by one operation; but where one-half turn is required several operations, after intervals of a few days, are necessary. The tooth is then secured in its new position by means of ligatures until a retaining plate is constructed and the necessary antiphlogistic treatment pursued. The danger of such an operation as torsion is the injury likely to occur to the vessels and nerves resulting in devitalization, and in no case should it be attempted

FIG. 161.

until the root of the deviating tooth is fully formed and sufficient space exists for its reception.

The use of vulcanized India-rubber is of great value in the correction of irregularities. The peculiar manipulations it requires will be found in another portion of this work; it is only necessary, therefore, in concluding this chapter, to briefly mention the properties which fit it for this important branch of dental practice.

It admits of absolutely perfect adaptation to the teeth. If only a part of the crowns of the teeth require fitting, a wax impression will be sufficiently accurate. But if the gum and under-cut surfaces of the

FIG. 162.

teeth are to be fitted, a plaster impression is necessary. Prof. Austen's method of taking plaster impressions in gutta-percha cups will enable a skillful operator to take an accurate impression of any mouth, however irregularly the teeth may be arranged.

A closely-fitting vulcanite plate can be worn with comfort; hence the patient is not tempted to remove it. It has no motion; hence does not wear the teeth or irritate the gums. Its firmness of adaptation makes it an excellent "fixed point" from which to make pressure or traction in any required direction upon the irregular teeth; the counter-pressure, being distributed all over the regular teeth, is not felt. When it is necessary to cap the molars, a layer of varying thickness should be carried over them all, to prevent the soreness caused by mastication upon any one tooth.

Any variety of appliances may be used in connection with the plate that the judgment of the operator suggests as best adapted to bring about the required change. The plastic nature of the crude material permits enlargement or extension in any direction, without

the necessity of soldering, as in metallic plates, and with sufficient exactness.

Thus, prominences may be left behind teeth which are to be moved outward, in which may be made dovetails for the insertion of compressed wood, slits or holes for India-rubber, which makes more rapid pressure than the wood, or holes for the insertion of small screws. These screws may bear directly against the tooth, and be turned slightly each day or two. Or the portion of the plate next the tooth or teeth to be moved may be separated, with a delicate saw, from the plate; the ends of the screw or screws playing into this move the tooth or teeth by a broad bearing, which will, in certain cases, be better than the point of the screw.

Or a small piece of vulcanized rubber may be taken, one end fitting against a molar or bicuspid, and into the other end a screw thread cut to receive a delicate screw; on the head of this screw a second piece of rubber may be fitted against the tooth to be moved, so as to allow the screw to be turned without changing its position on the tooth. This combination forms a miniature jack-screw similar to those recommended some years since by Dr. Dwinelle, and will often be found useful. It may be used in combination with the rubber plate by attaching one end to the plate instead of resting it against a tooth.

If it is desired to move a tooth by the elasticity of a spring, a vulcanite plate is made to fit closely to the mouth and teeth; one end of a metal spring is fitted tightly into a groove cut in the plate, so that the free end shall bear with the requisite force against the tooth. The elastic slip or spring, when made of vulcanized rubber, can readily be bent by means of a warm burnisher, so as to press with greater or less force, as the case may demand. Fig. 163, taken from Mr. Tomes' work, will illustrate one variety of the application of metal springs on a vulcanite plate, in this case pressing outward and laterally the left central and right lateral incisors. This mode of making pressure will be found very useful. It acts steadily, is under control, and does not need renewal so often as the wedges of wood or rubber. What are known as seamless collars can also be employed for rotating teeth, as follows:—

"To rotate a central incisor, take a fine wire and wrap it around the tooth, close to but not under the gum, and cut the wire so that its ends exactly meet to measure the circumference of the tooth. Straighten the wire without stretching it; find its equal in length on the collar diagram, and select the medium width collar numbered under that line. Take a piece of thick gold plate, shape it like Fig. 164, and solder it to the collar as seen in Fig. 165, using only

solder enough to unite the end of the lever, without flowing any solder over the collar to prevent it from fitting close on the tooth. Dry the tooth, smear its neck all around with oxyphosphate cement, and force the collar over the tooth so that the lever will be in position to be pulled by a ligature, or rubber ring, after the cement has become hard, which should take at least ten minutes. The applied fixture is shown by Fig. 166. A bar regulator that is to be anchored to molars or bicuspids may be likewise soldered to collars, which can then be cemented on the anchor teeth; or the bar may be adjustably connected with the collars, which are then fixed by cement on the teeth."

"Such fixed collars also serve as fulcra for jack-screws, the points of which will take on the metal of the collars so as not to slip, and yet

FIG. 163.

FIG. 164.

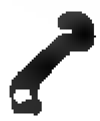


FIG. 165.

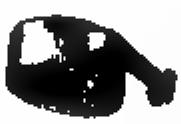
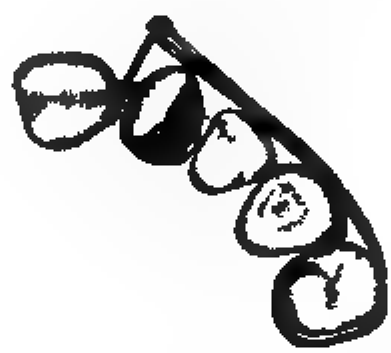


FIG. 166.



leave the enamel uninjured. Other similar functions will be found available in the collars for regulating purposes."

Where ligatures are required, the vulcanite plate affords an easy means of attaching them in any desired position; passing them through holes and tying; looping them over projecting knobs of vulcanite, or over small metal hooks set in the plate; or stretching them through slits sawn in the plate.

If a band is to be carried for any purpose in front of the arch, it may be connected with the plate on the inside of the arch, through any spaces occurring between the bicuspids or molars; if there are no such spaces, or if they are to be closed up in the process of regulation, the cap which is often required to pass over the molars will connect the two. But the outside band is not often necessary. The inside plate is less awkward to the patient; it is out of sight; and almost, if not quite, every required movement can be obtained from it.

Where the irregularity consists in some of the teeth projecting while others incline inward, such a case can be advantageously treated by the use of a vulcanite plate, the various stages progressing nearly at the same time. The impression in this case to be taken in plaster; the plate capping the second molars; first molars and first bicuspids carried outward by wooden or elastic wedges, or by a double spring of vulcanite fastened to the plate opposite each space of the extracted second bicuspids; the left central and right lateral carried out by wedges or screws; the right central and left lateral brought in by ligatures looped over hooks in the plate. At the completion of the work a new impression to be taken and the plate worn until the teeth become firmly fixed, the use of a retaining plate preventing a return of the teeth to their old positions.

FIG. 167.

Ligatures in connection with a vulcanite plate can also be employed for drawing irregular projecting front teeth to their normal positions, after the removal of posterior teeth (the second right and left bicuspids, for example), to afford the requisite space. Fig. 167 represents a case of torsion and retraction of the central incisors, with pins imbedded in the vulcanite plate for the attachment of the ends of the ligature.

FIG. 168.

FIG. 169.

FIG. 170.

FIG. 171.

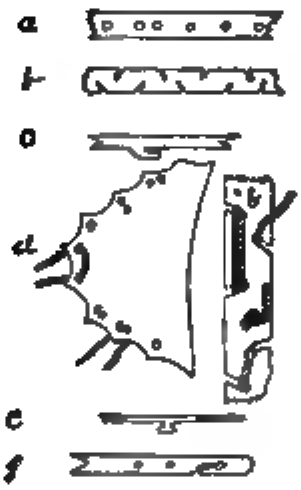
Studs of vulcanized rubber or celluloid, Figs. 168, 169, 170, 171, can be attached to rubber plates for the support of elastic rings

and moved from one position to another, as suggested by Dr. S. J. Shaw.

The late Prof. J. H. McQuillen recommended a strip of thick gold plate, similar to what is used for clasps, and curved to suit the arch, and so applied by means of rubber ligatures or rings as to draw forward irregular teeth. The ends of the bar are screwed to the bicuspid or molar tooth on either side, and the rubber ligatures or rings pass over the dovetail-shaped parts and the irregular teeth.

Fig. 172 represents portions of metallic bars, *a* and *b*, with holes and slits for elastic ligatures or rings; *c e f*, portions of bars with hooks and prominences for ligatures; *d*, plate, with holes for ligatures (Farrar).

Fig. 172.



Where the irregularity consists in one or more of the superior front teeth shutting within the inferior teeth various appliances have been recommended, the oldest, perhaps, being the grooved plate of Duval, and inclined plane of Catalan, which consisted of a simple circular bar or plate of gold, passing in front of the teeth from the first molar on one side to the first molar on the other, to which the inclined plane was soldered.

In the application of this principle for the correction of irregularity the author has been in the habit of constructing the apparatus somewhat differently. With a metallic die and counter-dies, he has a plate of gold struck up over all the teeth, when practicable, as far back as the first or second molar,

Fig. 173. Fig. 174.

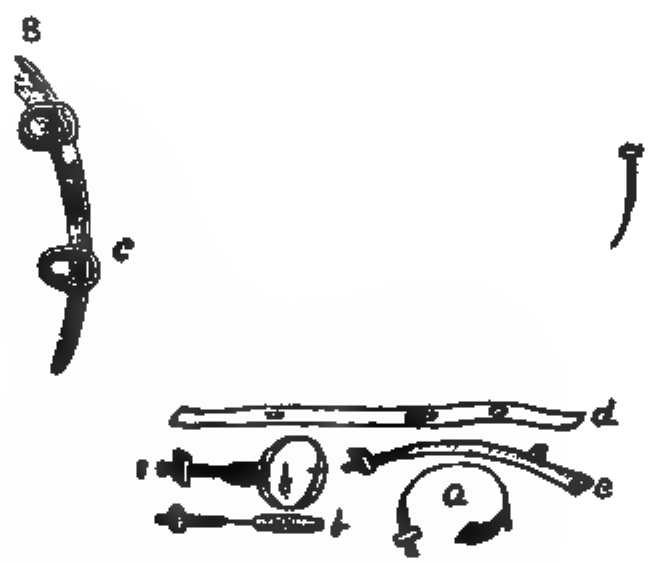
completely encasing them and the alveolar ridge. An encasement of this sort (Fig. 173) possesses greater stability than can be obtained for an appliance like the one invented by Catalan. The inclined plane represented by Fig. 173 can be more conveniently constructed of vulcanized rubber, which possesses advantages over metal for such an appliance.

If considerable time is required for the wearing of such an appliance as an inclined plane, injury may result, as the masticating teeth are prone to elongate and the proper articulation of the teeth be impaired; again, if the patient refuses to press the deviating teeth, on account of their sensitive condition while moving upon the inclined plane, the result desired will not be accomplished.

In Fig. 175 the letters A and B show a combination of an inclined plane with elastic ligatures, designed by Dr. N. W. Kingsley, to correct an irregularity of both upper and lower incisors, and the same apparatus was used as a retaining plate when the change was completed.

Two things are necessary in the treatment of this form of irregularity: first, to prevent the upper and lower teeth from coming

FIG. 175. FIG. 176.



entirely together by placing between them some hard substance, so that the overlapping incisors may not interfere with the necessary outward movement. The second is the application of some fixture that will exert a constant and steady pressure upon the deviating teeth until they pass those of the lower jaw.

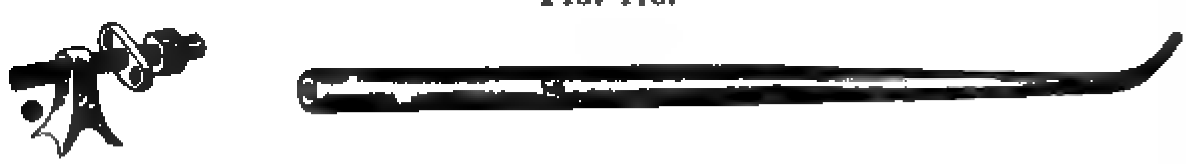
Fig. 176 represents another appliance of Dr. Farrar for correcting a form of irregularity where the teeth incline to the inside of the arch. The bar (*d*), in Fig. 176, is made of thick plate, about one-eighth of an inch wide, and is secured at one end (*c*) to a molar or bicuspid (or both) by means of a clamp-band (*a c* or *g*), while the other extremity rests upon a lateral incisor. This forms a bridge of the bar, which is pierced midway by an oblong hole, through which is passed a flat screw (*b b*), made by filing two sides, which prevents

its turning, one end of which is soldered to a thin plate (or it may be hammered thin) at the free extremity of which is soldered a thin band (b b), which fits tightly around the crown of the cuspid to be moved. To prevent the band from slipping a metallic pin-point may be soldered on its inside, to fit into a little hole drilled into the tooth (or the band may be attached to the crown by the oxychloride or oxyphosphate of zinc preparations and no hole drilled into the tooth). A nut (h) is then tightened, which draws the cuspid into position and at the same time forces the lateral incisor (which, in the case represented by the cut, is projecting) inward.

Fig. 177.

Fig. 177 represents another appliance designed by Dr. Farrar for drawing irregular front teeth outward which needs no explanation.

Fig. 178.



For drawing irregular projecting teeth, such as canines, into position the following appliance of Dr. F. H. Lee, which was designed as an improvement on a somewhat similar appliance designed by Dr. Littig, answers the purpose admirably:—

The Pull-back Jack-screw's special use is for drawing in obstinate canines which have erupted outside of the line of the arch, but it will work with equal satisfaction on any of the other teeth.

The post or nut is set in position and held by vulcanizing into a rubber plate fitting the mouth as shown in the cut (Fig. 178); the screw-bolt is then placed through the post and a wire or ligature

(wire preferred) is passed around the tooth, the ends being secured to the holes in the cross-head or swivel-block. The wire is then tightened from time to time as the tooth is brought to its place. To prevent the plate from being moved out of position by the strain upon it, it should be fastened to the teeth of the arch.

Figs. 179, 180, and 181 represent a form of irregularity consisting of the misplacement of the superior canines and lateral incisors,

FIG. 179.

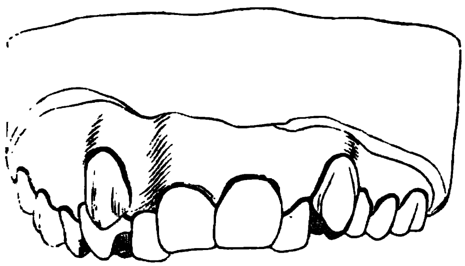
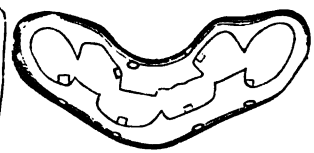


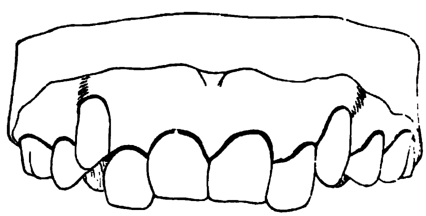
FIG. 180.



and the appliance designed by Dr. Joseph Richardson for correcting it, the principle of which was suggested a number of years ago by Dr. Redman.

In addition to the malplacement of the lateral incisors and canines there was some lateral contraction of the arch. After the extraction of the first bicuspids a narrow band of vulcanized rubber (Fig. 180) was constructed, embracing the six anterior teeth. Pressure was made upon the misplaced teeth by means of wooden pegs inserted in holes drilled through the band at such points as were indicated by the direction in which it was desired the teeth should take. The pegs rested against the posterior mesial angles of the lateral incisors in such a way as to force them outward and backward, while those inserted into the opposite or labial portion of the band carried the canines backward and inward. These pegs projected but slightly at first and were lengthened from time to time as the teeth moved.

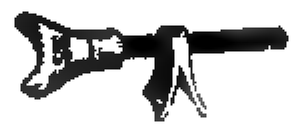
FIG. 181.



What is known as the "Lee-Bennett jack-screw" is an appliance suggested by Dr. G. W. Bennett (Fig. 182). It combines a swiveled-jack-screw with the forked post-nut of Dr. Lee's Pull-back (Fig.

178), so that any tooth may be pushed outward into line, as shown by the cut. On occasion both devices may be fixed in the same plate and be simultaneously operated, the Lee to pull back one tooth and the

Fig 182.



Lee-Bennett to push out another. Both of the operating screws may be turned by the same lever.

Figs. 183, 184, 185 represent a simple yet effective appliance suggested by Dr. E. S. Talbot for forcing out a tooth situated inside the arch, and which is described as follows:—

Fig. 183 represents a second inferior bicuspid within the arch, and the appliance, which consists of a thin, narrow, close-fitting

Fig. 183.

Fig. 184.

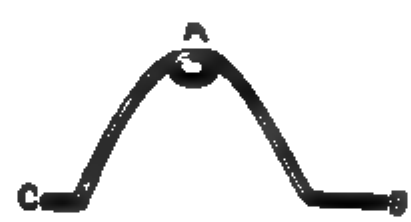
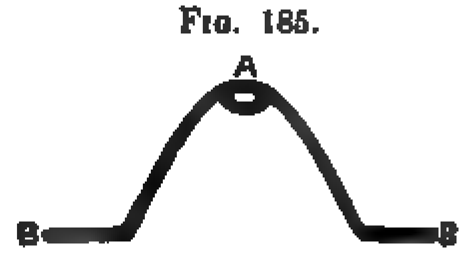


Fig. 185.



vulcanite plate, with a hole drilled through its middle, opposite the centre of the tooth to be moved. In the other side is another hole, but not drilled quite through the plate. Fig. 184 represents a

spring made of piano-wire, having a single coil, *A*, with the ends of its arms bent at a right angle. One of these ends, *C*, is cut short to enter the corresponding hole in the plate, and the other end, *B*, is left long enough to go through the plate and press upon the lingual surface of the irregular bicuspid, leaving a full eighth of an inch between that arm of the spring and the plate, as is shown in Fig. 188, which represents the spring in position. The plate and spring being separate can be readily removed for cleansing and to increase the power by spreading the arms of the spring. Fig. 185 represents a spring for the same appliance, having two long ends, *B*, *B*, which are designed for a case where two such teeth are to be likewise moved in opposite directions; the two holes in this case to be drilled entirely through the plate, so that the ends of the springs can be made to press against the lingual surfaces of the two deviating teeth.

Dr. Richardson also designed the following appliance, represented by Fig. 186, for shortening teeth elongated during the treatment for irregularity.

It consists of a plate affording fixed points of resistance and having clasps attached and pinned to the centrals with wooden pegs rest-

FIG. 186.

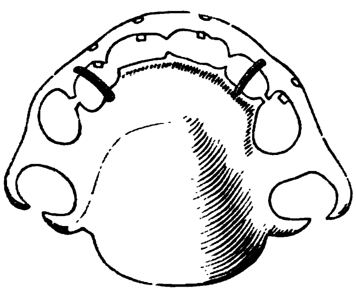
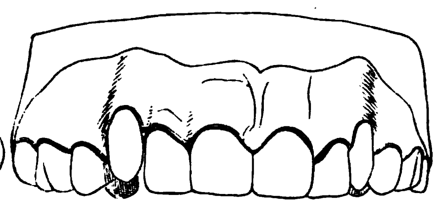


FIG. 187.

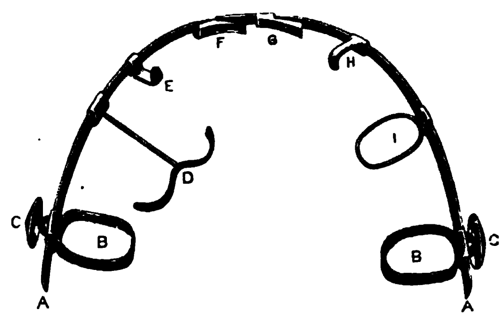


ing against their anterior and the plate against their posterior surfaces, as represented in Fig. 186. To this plate firm elastic cords were attached, stretching across the openings for the elongated teeth. When this plate was pressed firmly to its place upon the teeth and held securely by the means already referred to, the contractile force of the cords produced the necessary shortening of the elongated teeth. Fig. 181 represents the elongated laterals, as shown in Fig. 187, in their proper positions.

A system of regulating teeth, designed by Dr. Jno. J. R. Patrick, is simple and also effectual, and differs from any heretofore referred to. No cast of the mouth is required, and the appliances can be

readily cleansed, and may be used for an indefinite number of times. The power employed is the elasticity of a bow-spring (see Fig. 188), which consists of a half-round gold wire and platinum bar (A A), curved to correspond with the shape of the arch, having upon it a number of sliding rings, by means of which anchorage is secured and attachment made to the teeth to be moved. The bar is bent with its flat surface inward, and is of sufficient length to allow its ends to rest gently on the external lateral surfaces of the first and second molars as desired. The slides are fitted accurately, so as to move steadily. Two of these, which are made longer for the purpose, are used to secure anchorage by soldering to their inner surfaces thin gold bands (B B), previously fitted to the teeth selected. The bar is held in position by set-screws (C C) passing through them. Small buttons are soldered to their external surfaces, through which the screws pass, to give them greater purchase. To the

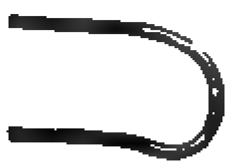
Fig. 188.



smaller slides the different appliances for moving teeth are attached, as wedges, hooks, V-bars, loops, and bands (D E F G H I), of various sizes and shapes, as required. The apparatus acts as a lever, of which the power is the elasticity of the bow-spring, the fulcrums the points used for anchorage, and the resistance the tooth or teeth to be moved. If these are outside the arch the bow-spring is adjusted so that its flat surface touches all of the projecting teeth, and is firmly set with the set-screws. The wedges are then forced together between the teeth to be moved and the bar; should the wedges cease to act before the teeth are properly placed, the set-screws are loosened, the wedges separated, and the bar taken up until its inner surface is again pressed against the projecting teeth, when it is again set firmly, and the wedges are again brought into play. To move teeth outward the elasticity of the bow-spring is made to draw upon them by means of the proper appliance.

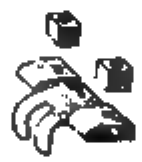
Rubber bands or ligatures may be made useful auxiliaries. This appliance can be used on either jaw. Should the bar at any time

FIG. 189.



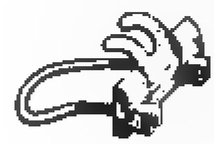
Molar Bow, A.

FIG. 190.



Molar Coupler.

FIG. 191.



Molar Yoke.

FIG. 192.

Bicuspid Bow, D.

exhibit a tendency to slip toward the gum, it can be held in place by snapping one of the slides provided with a hook over the cutting edge of a tooth.

FIG. 193.

Bicuspid Coupler.

FIG. 194.

Molar Yoke in place as an anchorage for a spring or rubber ring or ligature.

What are denominated "Yoke Regulators" are designed for use with Dr. Patrick's appliance. The yokes can be immediately fixed

FIG. 195.

Molar and Bicuspid Yoke Regulators with Patrick's bow-spring, wedges, and hook in place.

upon the teeth, and the manner of applying them is described as follows:—

The bow is to be passed from behind and between the teeth, however

close together these may be. The coupler is then put over the bow ends, a nut placed in the end of the key and carried to place on the bow. When the nuts have been screwed on, if the bow ends project they can be dressed off with a corundum point or be covered by a section of small rubber tubing stretched from nut to nut, or be wound with ligature silk.

Figs. 189, 190, 191, 192, 193, 194, and 195 represent these yokes, bows, couplers, and their application to Patrick's bow-spring.

As comparatively few cases of irregularity occur which in their

FIG. 196.

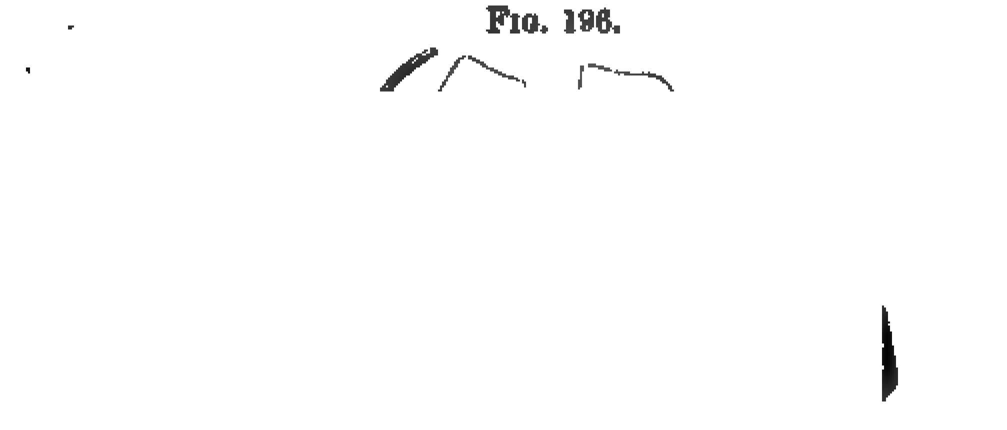
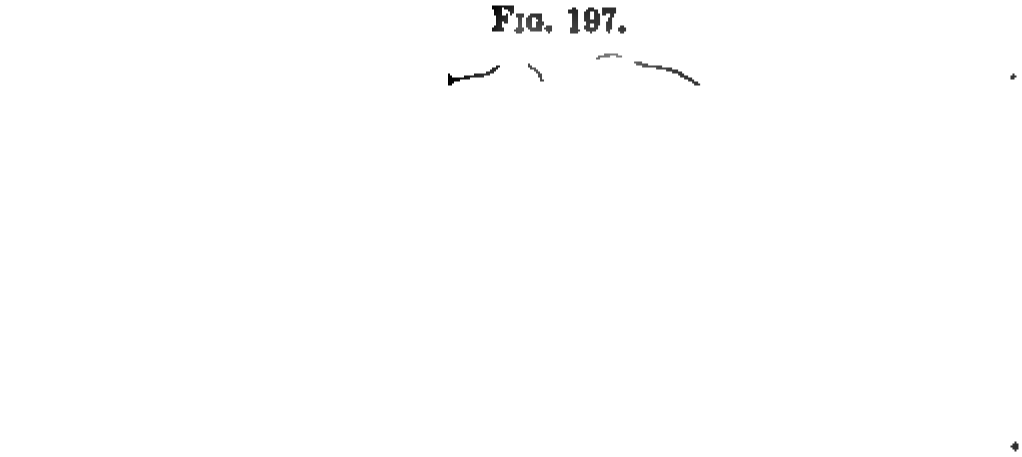


FIG. 197.



Figs 196 and 197 are typical appliances for the upper and lower jaws. The wire in Fig. 196 shows the form best adapted for expanding the anterior portion of the arch; that in Fig. 197 the form adapted to enlarging the posterior portion. The additional wire on the left of Fig. 196 was used, in the case above mentioned, to force the lateral incisor outward.

treatment do not require expansion of the arch, a number of appliances have been designed to accomplish such an object, such as a hinged metallic plate, the jack-screws, either by direct force or acting on split plates.

One of the most satisfactory appliances, however, for expanding the arch is the invention of Dr. Coffin, of London, Eng., which is represented by Figs. 196, 197. It consists of a thin vulcanite plate capping some or all of the bicuspids and molars and fitting the palatal or lingual surfaces of the anterior teeth, but divided along the

median line into two distinct halves, connected, however, by a steel-wire spring, so arranged that, while guiding and limiting the relative motion of the two halves of the plate, its tension exerted between them may be perfectly varied in direction and magnitude. The impression of the mouth should be obtained with gutta-percha, as it is elastic, and by its slight contraction in cooling affords a tightly-fitting plate, which, however, is not inserted in the mouth until it is divided.

The steel spring is made of piano forte wire, and is of the form shown in Fig. 198. To construct the spring two pairs of pliers are necessary and a pair of clasp benders. After cutting the proper length of wire, from one to two and a half inches in average cases, the wire being of a diameter between three- and four-hundredths of an inch (about 0.035 inch), it should be bent first in the centre and then back on each side, with the clasp-benders, holding it with the pliers, and thus giving the spring (as a serviceable form) the shape of a three- or five-curved serpentine figure, like a rounded capital W. It should also be bent to fit as nearly as possible the palatal surface of an upper model or the lingual surface of a lower model, and its ends should be flattened and roughened, without being softened by heat, for half an inch from the extremities. The plate being modeled in wax, the spring is placed on the surface, with its ends buried

Fig. 198.

Fig. 199.

Fig. 200.

within, and when removed by the counterpart, protected from the rubber by tin-foil before packing. In making the spring the flattened ends should be coated with tin; some are in the habit of coating over the entire spring, but this is not necessary, as the wire after it is worn becomes discolored with a polished appearance. Some recommend the insertion of a small piece of zinc in contact with

each of the ends of the wire, to prevent oxidation. Old piano-forte wire is considered to be the best for these springs. The plate, after being vulcanized, is finished in the usual manner, and is then divided with a fine saw, the edges and corners of the cleft being made round and smooth. It is recommended to have the patient wear the plate in the mouth for a day or two, to first eliminate any causes of irritation not due to its expansive action, before the tension is made by opening the spring. The patient can be instructed to increase the tension from time to time by slightly pulling apart the two halves of the plate and replacing it in the mouth.

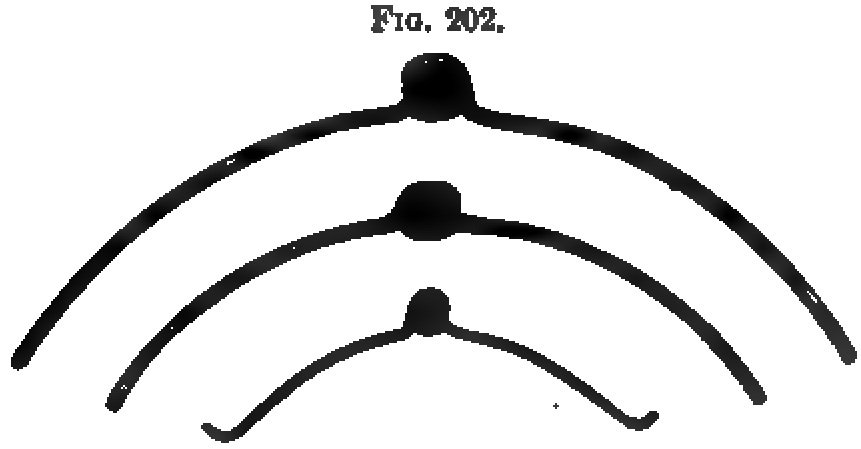
Figs. 199 and 200 represent modifications of the Coffin plate used for spreading the arch anteriorly and posteriorly, and by which the force is distributed over considerable surface.

Fig. 201 represents a slit plate and springs for pressing outward bicuspids and molars.

FIG. 201.

Another very satisfactory appliance for expanding either of the dental arches is the Talbot regulating spring, represented by Figs. 202, 203, 204, and 205.

FIG. 202.



On an accurate plaster model of the case to be regulated a thin, narrow vulcanite plate is formed, with a short vertical post fixed, either before vulcanizing or afterward, by drilling centrally in the

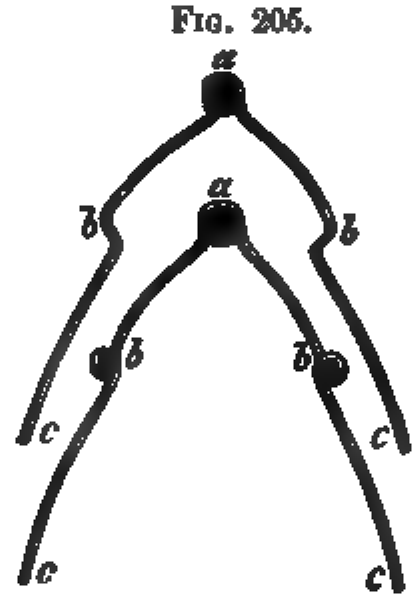
plate on the median line. By means of a wheel-bur, grooves or slots are cut in the sides of the plate to receive the ends of the spring and prevent its displacement after the coil has been placed on the post. The tension of the spring can be changed by bending its

FIG 203.

arms outward or inward. In the other cases grooves may be cut into the anterior and posterior parts of the plate, to correspond with and receive the points *b b* and *c c*, Fig. 205, and holes drilled at these points and the wire tied to the rubber plate. To move the

FIG. 204.

FIG. 205.



anterior teeth with the greatest force the arms can be so adjusted that the pressure exerted is greatest on the anterior parts of the plate. These springs, connected with split-rubber plates, can also be utilized for pressing outward bicuspid and molar teeth. They can also be employed in connection with platinum bands or collars fitted about the necks, to press deviating teeth outward, Figs. 206 and

207. The collars are attached to the teeth by oxyphosphate of zinc, after a hole is drilled in the side of each, and the spring is bent into form and the ends turned at a sharp angle so as to enter the holes in the collars. These springs can also be used for pressing out the central incisors when they shut within the inferior front teeth. A

Fig. 206.

Fig. 207.

rubber plate is made to fit the mouth as shown in Fig. 208, and two of these springs are vulcanized into it at the lateral incisor region. The arms are turned into loops at the extremities to secure a ligature. When the plate is adjusted the arms are bent horizontally

Fig. 208.

and brought in close proximity to the labial surfaces of the deviating central incisors, and securely tied.

Fig. 209 represents appliances of Dr. Farrar's to move irregular teeth—the first to draw teeth together and the second to separate irregular teeth in making space for another.

Fig. 210 represents an appliance, also of Dr. Farrar's, in position for drawing a cuspid toward a second bicuspid, after a first bicuspid has been extracted.

For moving a projecting incisor or cuspid backward, a gold spiral spring was formerly employed. It was found to be more efficient than a ligature of silk, inasmuch as it kept up a constant traction

upon the deviating tooth. But it is objectionable, on account of the annoyance it causes the patient. A ligature of rubber is far prefer-

Fig. 209.

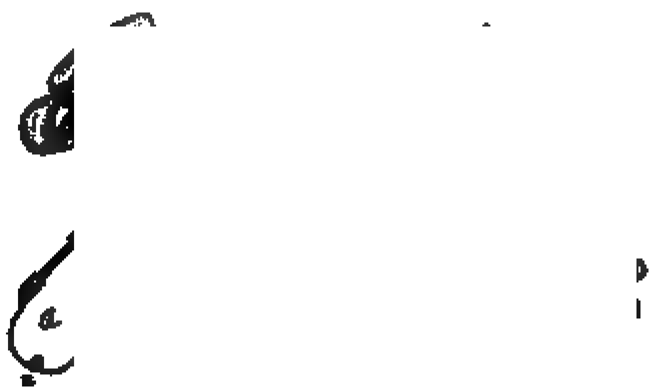


Fig. 210.

able, and this material is now very generally employed in the treatment of every description of irregularity in which simple appliances

are required. The difficulty of tying India-rubber ligatures is obviated by the use of several sizes of delicate elastic tubing (French manufacture), from which sections may be cut, more or less thick, according to the required length and power of the ligature. Each strip becomes thus an endless band, which may be readily passed from one tooth to another or to a hook on the plate.

Where the superior central incisors project beyond the inferior so much as to give a pointed appearance to the lip, Dr. Kingsley recommends the following regulating appliance (Fig. 211): a rubber plate fitting the roof of the mouth is constructed on a plaster model, taken from a plaster impression, in the same manner as any other vulcanized rubber plate would be made. This plate, which is made as delicate as strength and durability will permit, is cut away opposite the irregular incisors, so that there may be room for these to

FIG. 211.

be pressed in. The pressure, which is brought to bear in such a manner as not only to move these incisors, but act more or less upon the whole arch, is made by means of a very simple contrivance, such as a piece of gold, formed in the shape of a T, about a quarter of an inch in length, and with a staple or ring at the bottom of the upright portion of the T, through which a ligature may be passed. This ligature is a rubber ring, cut from a piece of small rubber tubing, and is passed through the eyelet in the T and then attached to the plate, reaching directly to the second molars on either side.

The plate being introduced into the mouth, the T is brought forward and passed between the central incisors, so that the cross-bar of the T is brought to bear upon their labial surfaces. If the incisors are in close contact, space is made for the gold bar forming the part of the T which projects into the mouth by wedging. The effect of

e will be to draw the central incisors inward and at the force the side teeth outward. To prevent the incisors ng to their abnormal position delicate rubber rings may g slipped over the incisors and attached to a close-fitting te of. rubber covering the roof of the mouth.

FIG. 212.

and 213 will represent a case of irregularity before and nent, in the treatment of which the appliance above applicable.

FIG. 213.

represents a similar appliance for correcting a form of consisting of the projection of the superior front teeth, rce is applied to all of the projecting teeth at once.

represents a vulcanite plate, with an alloyed gold and nd attached by means of screws, suitable for moving ting front teeth after the necessary space is obtained by

extraction of a bicuspid on each side. This appliance is very effectual and can be regulated by the patient using a common watch-key, or one made for the purpose, in order to increase the pressure

FIG. 214.

of the band upon the projecting teeth. Small hooks attached to the front portion of the band and passing over the cutting edges of the incisors prevent the band from slipping up to the gum.

FIG. 215.

Fig. 216 represents a form of special loop for drawing back the canines, and which is attached to the same plate, the band being removed until after these teeth are moved.

A special plate may be constructed for the moving of the canines, or but one plate be employed, made of the form represented by Fig. 215, and which can be afterward modified, as in Fig. 217.

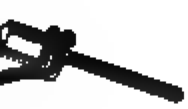
Dr. B. S. Byrnes has suggested a method of correcting certain forms of irregularities of the teeth by the motive-power of the

or elastic force of thin gold bands, which he described at of the Southern Dental Association, as follows:—

eference is gold of 20k. to 22k. fine, and, as a rule, the e bands the better the result. It frequently occurs, of t for special cases or for a special purpose during the f any case the band must be doubled in thickness, but oes not change the rule as stated. The pressure exerted ds is gentle but constant, and the teeth upon which they moved rapidly, with only the slightest inconvenience to . No plates are used, the fixed points for the application ve power being supplied by such of the teeth as are suited ose.

ethod of application is, in a general way, as follows: The ts having been determined, the tooth or teeth to be

IG. 216. FIG. 217.



are connected to them by means of a thin gold band. In he fixed points care should be observed to choose teeth offer greater resistance to the force to be applied than those to be moved will. The band is then manipulated so as to a spring or series of springs, so adjusted as to bear most on the misplaced tooth. Thus, suppose a projecting ntral incisor is to be drawn inward to align properly with der of the teeth in the arch. A continuous gold band the first molars on both sides is fitted around the outside s. With a dull-pointed instrument like a burnisher the hen pressed into the interstices of the teeth over which it s forming it into a series of small springs. The incisor, most prominent point, will naturally be most affected by the xerted by the springs, and in a short time it will be found ved away from the band so that it is no longer affected by

the tension of the springs. As soon as this occurs the apparatus is removed, the ribbon is annealed, straightened, and a small portion, say a thirty-second to a sixteenth of an inch, as may be required, is cut out of it. The ends are then soldered and the appliance is replaced upon the teeth, the connecting band being formed into a spring as before. Tension is thus kept up until the tooth has assumed the desired position.

"This is the plan of procedure in ordinary, simple cases of irregularity, but the method is equally applicable to more complex conditions. I have not yet seen a case since my adoption of this device where it could not be made to do the work of moving the teeth readily. Sometimes the spring of the band may be advantageously supplemented by other aids, as the insertion of a rubber wedge at points where a particular gain is desired, in accordance with the recognized principle that in regulating teeth the movement is greatest where the elasticity is greatest.

"One of the most important points to observe in the treatment of a case of irregularity is to always have the fixture so tight that it is not necessary to tie it on to the teeth. I frequently apply fixtures by degrees; that is, after making a snug fit, force the appliance partially to place, then allow an interval, sometimes of half an hour, before proceeding to complete the adjustment. I find this plan lessens the severity of the operation to the patient, not only because of the rest afforded, but because the teeth seem more inclined to yield, and thus allow the fixture to be placed more readily.

"To apply the rubber wedge, select a strip of rubber of the desired thickness. Place the gold fixture, which should fit perfectly tight, in position, and insert the rubber behind the band opposite to one of the interstices. Take the ends of the rubber in either hand, stretch it to its fullest extent, and gradually work it to the desired spot; then clip off the ends. Press the teeth forcibly in the direction in which you wish to move them with one hand, while with the burnisher in the other the band is pressed into the interstices.

"Case I.—The first case which I shall describe is that of a young lady who at the time she came to me was in her eighteenth year. The condition of her teeth at that time is well shown in Fig. 218. The missing right superior central had been extracted when the patient was about eleven years old, as the only relief from the unendurable pain following devitalization of the pulp at the hands of an itinerant dentist. To supply the deficiency a partial plate of vulcanite had been worn for the last three and a half years. The remaining anterior teeth of the upper jaw had been gradually forced

til at the time I first saw them they protruded at an angle
e degrees. In the lower denture the incisors stood within
he cuspids inclining forward. As a result of this con-
he chin was somewhat wrinkled and slightly upturned.
re a constant pout, the mouth being what may be termed

Fig. 218.

The molars being the only teeth which occluded properly,
was never naturally closed and the patient was unable to
cisive bite.

ting this case I aimed to compass four principal points:
truction of the 'peakedness' by producing a broader or
arch; 2d, the reduction of the projecting teeth to their
tion; 3d, the improvement of the articulation; and, 4th,
of the space caused by the loss of the right superior

mentioned was first undertaken. For the first two days
nd was used to force the ends or cutting-edges of the
l and left central together. A very thin, narrow gold
hen fitted to embrace the necks of these
nd a wedge of wood was inserted under
ide toward the cutting-edges, causing the
ove vertically toward each other. The
placed around the necks, and the wood spreading it
cutting-edges, caused very great pressure at the apex of
Another band (Fig. 220) was then constructed to move
backward and bring them into a more vertical position.
placed in position without removing the first (Fig. 219).
of two bands embracing the cuspids and bicuspids of
onnected by another band of the same material passing
he incisors. The connecting band was then pressed into
ces between the teeth and rubber wedges were inserted.

Fig. 219.

This fixture caused constant pressure backward on the anterior teeth and an outward pressure on the cuspids and bicuspids. The gold band acted as a lever, the lateral teeth as the fulcrum, and the posterior teeth as the weight to be moved. The connecting band was cut and shortened every other day, the patient having a sitting every day to allow the gold to be sprung more as the teeth moved away from it.

"At the end of three weeks the narrow band at the necks of the incisors was discarded, its work having been accomplished, and that shown in Fig. 220 was substituted by another, which passed around the outside of the whole arch from the first molar on one side to the corresponding tooth on the other. This appliance (Fig. 221) was required to do little actual work, its principal office being to hold the gain already made and to close the spaces between the teeth, which were now about equal in extent, and to bring the teeth to a vertical position. The gold was doubled in thickness over the incisors and

Fig. 220.

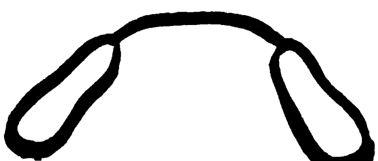
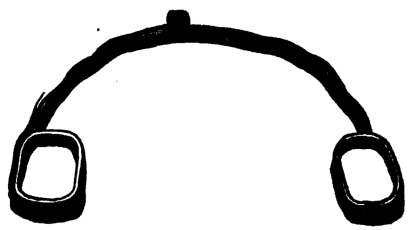


Fig. 221.



cuspids, to prevent its yielding while the backward movement was progressing, which would allow the arch to again assume the peaked appearance which the treatment was undertaken to correct. The small hook or catch was to prevent the band from slipping up toward the gum, which it showed a tendency to do when first applied. The patient now wears a similarly shaped band, but only one-third as wide, as a retaining piece, which she removes and reapplies at pleasure.

"The treatment of the irregularity in the lower anterior teeth was begun about a week after work on the upper jaw was commenced, and was completed in three weeks. A band, constructed as shown in Fig. 222, was applied, clasping the first molars on both sides and passing around the cuspids and behind the incisors. A wooden wedge was placed between the incisors and the band and springs formed by pressing the band into the interstices between the cuspids and bicuspids, cutting and readjusting as before. In two weeks this fixture was substituted by another (Fig. 223). This

band clasping the incisors, with wings tipping upon the
l having the portion behind the incisor doubled in thick-
tle block of rubber inserted under each of the wings com-
vork in a week's time. The wings were then pressed back

FIG. 222.

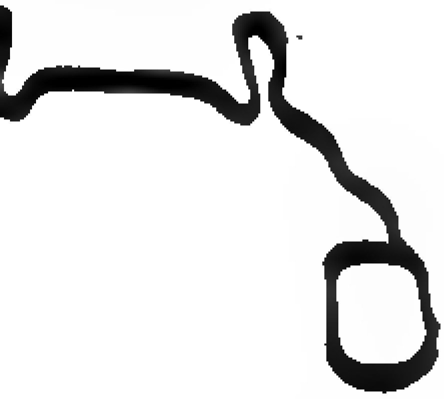


FIG. 223.

gain, and a piece given to the patient to wear as a retain-

4 is an accurate representation of a cast of the mouth
ne conclusion of the operation. The correction of the
s in this case was accomplished in a month, work being
ward simultaneously in both jaws after the treatment of

FIG. 224.

teeth was commenced. The work of moving the upper
ushed so rapidly as to slightly 'spring' the maxillary at
nent of the compressor nasi and the depressor alæ nasi, so
ngs of the nose were pulled laterally inward and down-
ng a slight bulging or bridge on the centre of the nose.
the patient some six months after the case was dismissed,
scles had adjusted themselves and no deformity was visible.
t then informed me that she had never had any trouble
of the retaining fixtures.

"Case II.—Patient a lady, aged twenty-seven. The occlusion of the teeth was very faulty (Fig. 225). The lower cuspids closed in front of those in the upper jaw, giving to the chin an angular shape, and the deformity was becoming more conspicuous from day to day. The dentes sapientiæ were just erupting into a crowded arch,

Fig. 225.

causing considerable pain throughout the denture, and pushing the lower cuspids still further forward. As the wisdom-teeth were well developed, I decided to extract the first bicuspids to make room for them, and this was accordingly done. The threatened trismus disappeared promptly, and the work of bringing the cuspids back into position was begun. Two gold bands (Fig. 226) were applied, one

Fig. 227.

Fig. 226.

on each side, embracing the first molar and cuspid. The bands were sprung into the interstices on both the buccal and lingual surfaces of the teeth. During the early portion of the treatment heavy bands were used, which were made to fit tight and forced to place, each cuspid being pressed backward with the thumb of the left hand while the gold band was pinched into the interstices with a pair

eps. The molars were capped the first week, to permit in the opposing jaws to pass each other freely. As ab-oceeds slowly at the age of this patient, it was deemed to push the work rapidly, and the bands were therefore htened only twice a week. As soon as the cuspids were ck from their inclined position the case became a very to treat, as the arrangement and shape of the teeth to put on very tight bands. The treatment was com-n weeks. Fig. 227 is from a cast made after the conclusion .

trating the convenience with which the apparatus was mention that the patient was a vocalist of considerable

FIG. 228.

during the whole period of the treatment was enabled to sing accuracy of tone and enunciation.

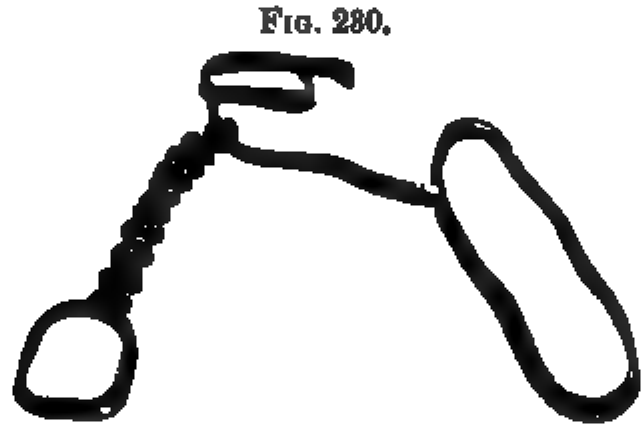
II was corrected in eight sittings. The patient was a lady, y-two years. When about ten years old she fell, strik-e teeth of the upper jaw in such a way as to knock out teral and dislocate the other incisors, the left central re-an angle of 35° after its attachment to the alveolus was The incisors gradually separated from each other, the een the centrals at the cutting-edges being more than an n inch. The cuts give a very accurate idea of the ex-deformity, which was very marked. Previous to my ase, a dentist in Ohio had attempted to bring the teeth position by means of a rubber band passing from the over the little lug seen on the plate between the centrals ; but this attempt failed, as the resistance was almost e power employed. The appliance I used in correcting

this case is shown in Fig. 229—a simple gold band extending from the second bicuspid and first molar on the right side as base across the mouth to the central to be moved. Here there were no teeth to be utilized in forming the connecting-band into a series of springs, but this was readily accomplished by crimping the band as shown.

FIG. 229.

"Fig. 230 shows a somewhat more complicated apparatus than any of those previously described. It was used in a case where the right central overlapped the lateral. It illustrates how the method which I advocate may be applied to turn a tooth where the force must be applied directly across the mouth. After the necessary room was provided this fixture was applied. It accomplished its

FIG. 230.



work in four days, after which a retaining device was applied, consisting of a simple band, clasped tightly around the central which had been rotated, and provided with wings tipping on the left central and under the right lateral.

"There are very few forms of irregularity of the teeth to the correction of which the method I have endeavored to describe may not

So far, since I began to use it, I have found none, and I many cases."

and 232 represent an ingenious appliance of Dr. Farrar moving the apices of the roots as well as the crowns of nsists of gold clamp-bands operated with a screw; fullaced between the teeth, to prevent the crowns from

. 231.

FIG. 232.

r than the entire roots, these fulcrums being replaced nes as the teeth, under the pressure of the clamp-band, h other.

plates are generally required after the operation of movom irregular to regular positions is completed, for the

FIG. 233.

culty in correcting irregularity of the teeth is often he tendency of such teeth to return to their old positions. y, therefore, that retaining plates should be worn until d teeth become firmly fixed; and no definite time, average time may be stated as that of one year, can be

given for the completion of such a process. Before permanently removing a retaining plate its use may be dispensed with for a short time, an examination being made daily to determine if there is any tendency of the corrected teeth to return to their irregular positions.

A simple form of retaining plate, to be worn after the correction of an irregularity caused by the projection of the superior front teeth, is represented by Fig. 233, which is a simple vulcanite plate with a small gold wire attached to it and passing to the outside of the front teeth through a small opening between the canine and bicuspid teeth on each side. After the correction of a contracted arch a simple vulcanite plate, such as is represented by Fig. 234, will answer as a retaining

FIG. 234.

FIG. 235.

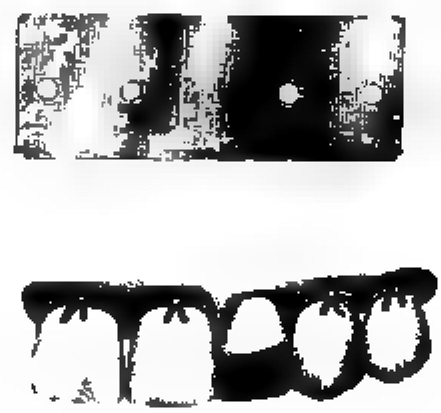


plate. A plate of this kind should be adapted to the palatal surfaces of all the superior teeth.

Fig. 235 represents an ingenious application of the rubber dam for the retention of replanted teeth and which may also be utilized for the retention of one or more irregular teeth after treatment, which is the suggestion of Dr. Herbst. The idea is so plainly shown by the illustrations that further description is unnecessary.

Wedges of elastic rubber are often useful in cases where the lower teeth shut outside the upper ones. They should be used of such a thickness as will exert a gentle pressure only.

Fig. 236 represents a case of this kind, with the wedges in position.

The jack-screw is also a valuable appliance for regulating teeth. Its use was first suggested by Dr. William H. Dwinelle, and it has been applied alone or in connection with a split-vulcanite plate. Figs. 237 and 238 represent different styles of jack-screws, the old and new, which are operated by holes in the middle bar; other holes render them capable of being secured to a tooth, thus avoiding the danger of being swallowed if accidentally detached. In some cases,

e first style of screw has been permanently imbedded in ate.

Fig. 236.

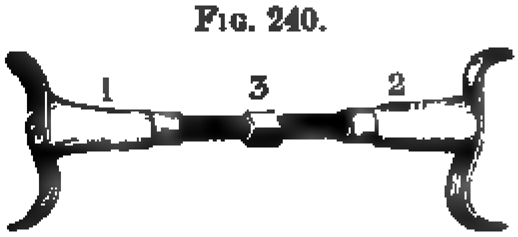
Cryer has designed an appliance by the use of which no to the teeth while the jack-screws are in operation.

Fig. 238.

Fig. 239.

thin platinum bands or clasps fitted to the teeth, the oldered or held together by a small screw. The clasp

Fig. 240.



es the tooth to be forced outward contains a small eception of the point of the jack-screw, and upon the

other clasp, which may encircle several teeth used as a fulcrum, small lugs are soldered, between which the other end of the jack-screw, which is of the form of a crotch, fits tightly, and is thus prevented from slipping.

Fig. 239 represents a vulcanite split-plate with a jack-screw in position.

Fig. 240 represents a screw which is a combination of the two forms already alluded to, having upon its end a revolving crutch.

FIG. 241.

Levers are also used with advantage on the outside of the arch, to press with a gentle force a deviating tooth, and thus move it into a proper position.

Fig. 241 represents a plate of vulcanized rubber with levers or springs attached.

FIG. 242.

Shortening the teeth has already been referred to in several of the cases presented, and it remains only to allude to an apparatus de-

r. Kingsley for such an object. It consists of a frame ted to the cutting edges of the incisors and lapping on s, to which is added a stud or post about half an inch in red to it opposite the canines, and coming out of each e mouth. This apparatus is shown by Fig. 242. The upward, passing outside the cheeks, and consist of metal elastic ligatures to a skull-cap. Fig. 243 represents the tus in action.

ening a short tooth Dr. J. D. White suggests the simple ing a thread ligature tightly around the neck of the tooth, e margin of the gum, and if much irritation and pain

'IG. 243.

FIG. 244.

nove the ligature and, keeping the tooth at rest, apply a d ice, in a bag, to the gum. After a week's rest the same to be pursued every alternate week, until the end is l. But great care is necessary to keep the irritation r bounds, this treatment being applicable only to growing gh occasionally to matured teeth also.

ving is an appliance designed by Dr. Farrar to bring er place in the arch an impacted canine, represented by ich will also prove effectual for elongating a tooth. It narrow gold plate (see Fig. 245), swaged to fit the palatal he gum and surfaces of the lateral incisors and bicuspids, ss bars, or a clasp around the first bicuspid, connecting

this plate with a smaller one adapted to the labial margin of the gum. To the small plate or pad, as it is termed, a smooth nut is soldered, through which passes a screw, its lower end bent so as to enter a small hole drilled into the crown of the short tooth, which, by means of a thread-nut, is forced downward.

The elongated tooth is retained in its new position by the delicate apparatus represented by Figs. 246 and 247.

The action of an elastic spring, the free end of which acts upon the short tooth while the other is imbedded firmly in a rubber plate, will often answer the purpose of elongating a tooth.

Dr. A. E. Matteson has suggested an appliance to force the eruption of teeth which are impacted in the jaw in such a manner as to

Fig. 245.

Fig. 246.

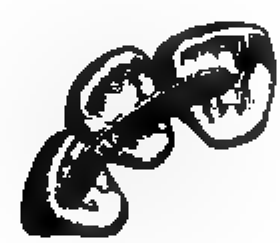


Fig. 247.

prevent their occluding or meeting with the opposite ones when the jaws are closed. It is described as follows: A rubber plate is made to cover the roof of the mouth and to fit the necks of the teeth closely. A French clock spring is adjusted to the rubber plate in such a manner that one end is riveted into the central posterior part, so that when the spring is forced up against the plate its distal end touches the necks of the teeth to be drawn out. Ligatures are then fastened to the necks of the teeth and the spring carried up to the plate and secured to the teeth (Fig. 248). With a sufficiently powerful spring from two to four teeth may be operated upon at one time.

Fig. 249 shows a similar appliance for operating upon impacted lower teeth.

same purpose, Dr. E. S. Talbŏt suggests the following A rubber plate is made to fit the jaw and the teeth, into le is drilled at a point in the centre of the space made sing or impacted tooth, smaller than the one arm of the pring it is to hold. The other arm of the spring, upon

FIG. 248

FIG. 249

which is a loop (Fig. 250) meets the neck of the tooth to and is there secured with a ligature. When the tooth is d in the process that a ligature cannot be fastened to it, band with a hook soldered upon it may be forced up gum and secured with oxyphosphate of zinc. If this may be drilled into the crown of the tooth and an eye-

FIG. 250.

ed in with cement, to which the spring can be secured of a ligature. By drilling the hole in the rubber plate at a ance from the impacted tooth, a greater spring is given to

ty from Excessive Development of the Teeth and Alveolar Ridge Jaw.—When the teeth of the lower jaw form a larger arch of the upper, the incisors and cuspids of the former shut those of the latter, causing the chin to project, and other-ring the symmetry of the face. Figs. 251 and 252 present

a front and a side view of this deformity. It may result from a want of correspondence in the development of the teeth and alveoli of the two maxilla, the upper jaw being defective in size, while the lower jaw is natural; or the former being natural, the latter may be in excess. It may also arise from a simple eversion of the lower teeth or inversion of the upper.

Treatment.—The remedial indications of the deformity in question consist in diminishing the size of the dental arch, which is always a tedious and difficult operation, requiring great patience and perseverance on the part of the patient and much mechanical ingenuity and skill on the part of the dentist. The appliances to be employed have of necessity to be more or less complicated, requiring the most perfect

FIG. 251.

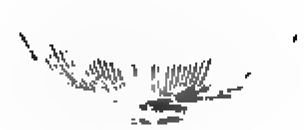


FIG. 252.

accuracy of adaptation and neatness of execution; they must also be worn for a long time, and, as a natural consequence, are a source of considerable annoyance. The first thing to be done is to extract the first inferior bicuspids. Sufficient room will thus be obtained for the contraction which it will be necessary to effect in the dental arch for the accomplishment of the object. An accurate impression of the teeth and alveolar ridge should be taken with wax softened in warm water, and from this impression a plaster model is procured, and afterward a metallic die and counter-die, in the manner to be described in a subsequent chapter.

This done, a gold plate of the ordinary thickness should be swaged to fit the first and second molars (if the second has made its appearance, and if not, the second bicuspid and first molar on each side), so as completely to encase these teeth. If these caps are not thick enough to prevent the front teeth from coming together, a piece of gold plate may be soldered on that part of each which covers the grinding surfaces of the teeth. Having proceeded

a small gold knob is soldered to the inner and outer front both caps, and to each of these a ligature of silk or rubber ed. These ligatures are to be brought forward and tied round the cuspids. When thus adjusted the lower arch ent the appearance exhibited in Fig. 253. By this means ds may, in fifteen or twenty days, be taken back to the If in their progress they are not carried toward the t of the alveolar ridge, the outer ligatures may be left off w days, and the inner ones alone employed to complete the r of the operation.

the positions of the cuspids have been thus changed, a bar of gold should be made, extending from one cap to the as to pass about a quarter of an inch behind the incisors, ldered to the inner side of each cap. A hole is to be made this band, behind each of the incisors, through which a of silk may be passed and brought forward and tied tightly

FIG. 253.

FIG. 254.

f each tooth. These ligatures should be renewed every day teeth are carried far enough back to strike on the inside of ponding teeth in the upper jaw.

4 represents the appearance which the lower jaw presents ast-named apparatus upon it, and will better convey an idea struction, the manner of its application, and its mode of an any description which can be given.

pliance of this sort may be made to act with great efficiency ying the deformity in question; but in its application it is that the caps be fitted with the greatest accuracy to the d they should be removed every day and thoroughly as well as the teeth they cover. If this precaution is neg- e secretions of the mouth, which collect between the gold teeth, will soon become acid and corrode the latter.

The remarks made in the previous chapter upon the use of the vulcanite are applicable here. Such a plate, for this class of cases, is readily made, and inflicts no injury upon teeth or gums. Elastic instead of silk ligatures might be used, and the retraction of the incisors carried on simultaneously with that of the cuspids. The use of vulcanized rubber instead of gold is of great value in correcting irregularities of this nature, the form of the appliances being the same.

The employment of elastic rubber ligatures in connection with vulcanite plates is generally found to be effectual in correcting the irregularity of the inferior front teeth. The following appliances, from designs of Dr. Kingsley, will be found serviceable:—

Fig. 255.

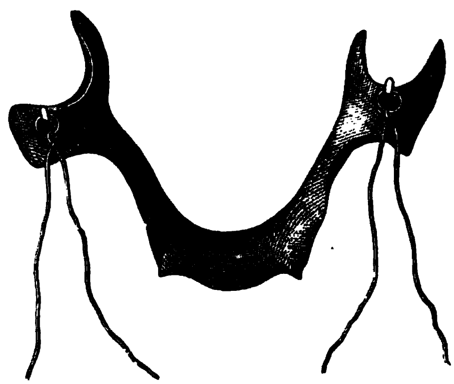


Fig. 255 represents an appliance for correcting an irregularity where the inferior canine teeth stand outside the arch, which is somewhat narrow, the first permanent molars being first extracted. Hooks of gold wire are inserted in the plate as points of attachment for the elastic bands, which are drawn forward and attached to the canines by silk or linen threads. By such means the canines were drawn into position and the arch widened.

Fig. 256 represents other forms of attachment for elastic bands and ligatures.

Fig. 257 shows an appliance for correcting the irregular arrangement of the four inferior incisors. Gold wire hooks (A A) pass over the arch between the canines and adjoining teeth, in order to give an independent attachment for the elastic ligatures outside as well as within the arch, and movements in almost any direction can be

For cleansing purposes such appliances can be removed
ced by the patient.

ion of the Lower Jaw.—This deformity, although produced
rent cause from the one last described, is similar to it, and
he lower part of the face an unnatural and sometimes dis-
appearance. It also interferes with mastication, and often
hension and distinct utterance. It wholly changes the
ip which the teeth should sustain to each other when the
closed. The cusps or protuberances of the bicuspids and
f one jaw, instead of fitting into the depressions of the
ding teeth of the other, often strike their most prominent
t other times the outer protuberances of the lower molars
spids, instead of fitting into the depressions of the same

Fig. 256.

Fig. 257.

eeth in the upper jaw, shut on the outside of these teeth.
ration of aliments is consequently rendered more or less
.

rotrusion of the lower jaw is supposed by some to be the
a "natural partial luxation." In fact, its causes are by no
early understood. It is often hereditary, and would seem
sed by that mysterious agency which impresses peculiarities
h and shape, not only upon the lower maxilla, but upon
ne in the body. The agency is so constant and overruling
must be prepared to find the jaw returning to its position
discontinuance of treatment, unless, by the interlocking
sps of the upper teeth and the overlapping of the upper
we can restrain the tendency. It is of more frequent
e than the one which results from excessive development
eth and alveolar ridge, and requires, as before stated, an
different plan of treatment. It rarely occurs previously to
entition.

Treatment.—The plan of treatment formerly adopted consisted in fastening on each side a cap of vulcanite on one of the lower molars, thick enough to keep the front teeth about a quarter of an inch apart when the jaws were closed. Fox's bandage was then applied. This was buckled as tightly as the patient could bear with convenience, pressing the chin upward and backward. A piece of tough wood, slightly hollowed so as to fit the arch of the lower teeth, made narrow at the upper end, was introduced between the teeth several times a day, the concave portion resting upon the outside of the lower and against the inside of the upper, employing at each time as much pressure as could be safely applied. By continuing this operation from day to day, for several weeks, the natural relationship of the jaws would, in most cases, be restored.

Fig 258.

The description of bandage here alluded to, and the manner of its application, is represented in Fig. 258. When the protrusion of the lower jaw is accompanied by irregularity, means should at the same time be employed for remedying it. The earlier the treatment is instituted the more easily will the deformity be overcome. It may, however, be successfully remedied at any time previously to the twentieth year of age, and sometimes at a much later period, but after this time the operation becomes more difficult.

An appliance designed by Dr. G. S. Allan (Fig. 259), and which he employed successfully, consists of a brass plate to fit the chin, having arms with hooked ends reaching to a point just below the point of the chin. The arms are arranged in such a way that the distance between them can be altered at will by simply pressing them apart or together. The upper part consists of a simple network going over the head and having two hooks on each side, one hook being above and the other below the ear. The network and the chin-plate are connected by four elastic rubber ligatures exerting pressure in such a manner as to force the lower jaw almost directly backward. The upper elastics are used simply to keep the mouth closed so that the lower elastics will not pull it open, the upper being made just strong enough so that the muscles of the mouth need not be strained to keep the jaw open during the operations of eating and talking.

es where the lower front teeth close over the upper, and th
leformity of the face, it is important to discriminate correc
those which result from malformation and a protrusion
occasioned by partial luxation, as the remedial indications
re entirely different. Those which would prove successful
would prove unsuccessful in the other. But, fortunate
arising from the last-mentioned cause is comparatively

Fig. 259.

rrence; hence, the dentist is seldom called upon to exerc
uity and skill in its treatment.

lward Angle's system of correcting irregularities of the tee
ed by him as follows:—

tudying the conditions by which we may best accompli
ements of the teeth, we may simplify the process if we
the movements in the line of the arch, which are five: f
ckward, inward, outward, and partial rotation. These a
ght modifications, with the exception of elongation and d
which are rare, are all we are called on to perform. T
governing all of these movements are the same. So th
standing the principles governing one, we may comprehe

plying force to a tooth, it should be sufficient to acco
movements as rapidly as is consistent with physiologic

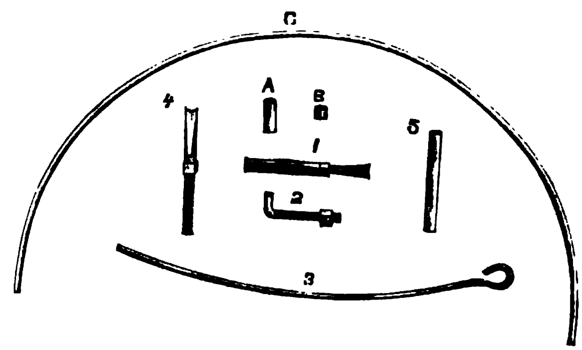
law. When pressure is once applied it should be continued without relinquishment, for there should be no retrogression of the tooth.

"The appliance for accomplishing the movement of a tooth must be so perfect in design, construction, application, and operation, that there should be no need for its removal till its object is accomplished.

"After the mal-posed tooth has been moved into the desired position and proper occlusion secured, it should be firmly supported and retained till it has become firm in its new socket.

"A strip of 32 to 36 gauge platina, about ⅛ of an inch wide, is made into a loop and slipped over the tooth to be banded. The ends are now grasped close to the tooth with a pair of flat-nosed pliers and the band drawn tightly around the tooth, a strong burnisher being applied

FIG. 260.



at the same time, to still further make it conform to the shape of the tooth. A small bit of solder is now placed on the band at the junction and all carried in contact with the flame of the soldering lamp. After it is soldered the ends are chipped off, and the band is now complete and ready for any attachments which may be made, after which it is cemented in position on the tooth.

"For accomplishing the different movements of the teeth I use the following simple appliances:—

"Fig. 260 shows two forms of the screw: one for pushing, as shown at 1; one for pulling, as shown at 2; and a lever for rotating, as shown at 3. For making and using these appliances, use Stubb's steel wire of two sizes. You will also need jewelers' gold-plated wire and hollow wire, or, as it is known among jewelers, 'joint wire,' which may be of either gold or silver, and a few pieces of piano wire. The screw for pushing is made by cutting a thread on a piece of

eel wire of the desired size and length. One end
beaten flat, and to the other end is screwed a sma
platinized gold. This, complete, is shown at 4. A p
wire is now sawed off, the desired length. The sc
to this pipe, and the whole is now complete and rea
own at 1. This style of screw may be made any
e largest I have yet made being $2\frac{1}{4}$ inches in leng
inch.

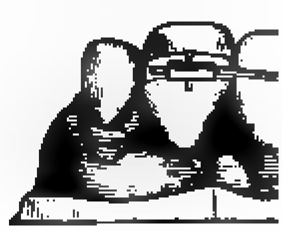
raction screw is made of Stubb's steel wire, in a
the screw just described, with the exception that one
is bent sharply at right angles. The screw comp
2. The entire length of the screw is about $\frac{3}{4}$ of an in
ent portion $\frac{3}{32}$ of an inch.

ever is made of a piece of piano wire (No. 13) ab
ength, bent at one end into the form of an eye. It is
at 3.

on by means of this instrument is accomplished by ba
to be rotated. Before cementing the band in posit

FIG. 261.

FIG. 262.



a piece of joint-wire $\frac{1}{4}$ inch long is soldered on to the
bial or buccal surface, at right angles to the axis of the
is now cemented in position on the tooth. The straig
ano wire is inserted into the little pipe in the ban
sprung round and made fast by a wire ligature to th
e eye in the end of the lever. Fig. 261 shows an
ted by this method.

the tooth has been moved into position it is retai
the spring and inserting a piece of the gold-plated wi

the tube from the opposite side, long enough for the end to rest on the labial surface of the tooth adjoining, as shown in Fig. 262. The piece of wire is prevented from turning or working out, by passing a fine drill through the pipe and one side of the wire, and inserting a neatly-fitting piece in the hole thus made.

"For accomplishing the movements of a tooth from *within outward* into the line of the arch, the screw first described is used in the following manner: The tooth to be moved is banded and piped in the same manner as described in rotation; then into the palatal side of the band is formed a slot, into which is inserted the flat end of the screw. Resistance is gained for the base of the screw by selecting a sufficient number of teeth to completely resist the pressure of the moving tooth.

"These teeth are banded and piped close to the gum and on a line with it. A piece of the gold-plated wire is threaded through these little pipes, either before or after cementing the bands in

Fig. 263.

Fig. 264.

position. Against this wire is placed the base of the pipe encircling the screw. A suitable notch is fitted into the end of the pipe to fit the wire and prevent it from slipping; or, if this wire of resistance is placed on the outside of the arch, as may be done with advantage in many cases, the base of the pipe is rested against one of the bands encircling one of the teeth. It is prevented from slipping by soldering it in position, or by plugging the end of the pipe and filing it to a sharp point. The point rests in a pit formed in the band. Fig. 263 shows the screw in position in moving an inlocked cuspid.

"Force is applied by tightening the nut with a small wrench after the tooth has been moved into the line of the arch. If the

of rotation is necessary the lever is applied, after which ed by inserting a piece of the plated wire into the little end of the wire resting against the outer surface of the h side is shown in Fig. 264.

vement of a tooth *inward into* the line of the arch is d by banding the tooth. To the palatal side of the to and on a line with the gum, is soldered one of the little an inch long. Into this pipe is hooked the angle of the ew. Resistance is gained by banding piping on one or on each side of the tooth to be moved, the pipes being se to and on a line with the gum. Through these little before or after cementing in position, is threaded a piece d wire.

e is now exerted by the screw pulling through and the against the end of another of these little pipes soldered of resistance. Fig. 265 shows a lateral incisor being drawn

FIG. 265.

FIG. 266.

The nut is tightened as often as necessary. The end of snipped off from time to time to prevent its chafing the

e tooth has been drawn into line the wire of resistance tion screw are removed, and the tooth is retained in posi- rting a piece of the plated wire into the little pipe before the angle of the traction screw, the wire being long he ends to rest against the palatal surface of the tooth on shown in Fig. 266. The retaining wire is held in position Fig. 262.

ovement of a tooth backward in a line of the arch is d by banding the tooth to be moved. To the outward

surface of the band is soldered one of the pipes $\frac{3}{32}$ of an inch long, at right angles to the tooth and line of the arch. Into this pipe is hooked the angle of the traction screw. The other end of the screw passes through and the nut works against the end of the pipe soldered to the bands encircling the teeth to be used in overcoming the resistance of the tooth being moved. Fig. 267 shows a cuspid being drawn backward. It will be seen that the movement, tipping, which is the ideal, is thus gained, and though the pressure is exerted on one side of the tooth only, yet rotation is impossible, as it moves backward. It will also be seen that the resistance is complete, as the teeth used for this purpose cannot tip, but must be dragged forward bodily through the alveolus. The screw is snipped off from time to time as it emerges through the pipe and chafes the cheek, or the cheek may be

FIG. 267.

protected by covering the end of the screw with a piece of warm gutta-percha.

"After the tooth has been moved backward the desired distance it is retained there by the screw being kept in position, or it may be removed and a piece of gold wire inserted in its place.

"The movement of the tooth forward in line of the arch is accomplished in the same way, only selecting teeth from the opposite side to be used in overcoming the resistance of the teeth being moved.

"The expansion of the arch is accomplished by placing a bar of heaviest piano wire against the palatal side of the arch, one on each side. They are held in position by the ends in front passing through little pipes soldered to bands encircling the cuspids. The

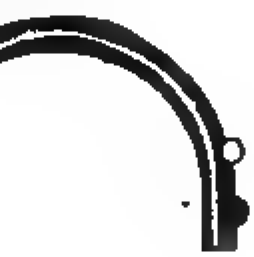
ds are kept in position by the ends of the wire being bent ight angles, and hooked into little pipes attached to bands he last molars.

will be seen that two rigid bars of steel, one on each side, nly in contact with the teeth. As shown in Fig. 269, pres- exerted by placing the screw first described directly across opposite ends resting against the bars of steel; expansion tightening the nut on the screw.

r method of applying pressure against these two bars is to e of heavy steel wire to conform to the curve of the arch bar to bar. At the side near one end is filed a notch

FIG. 269.

FIG. 268.



y one of the bars which it is to rest against. The other n slightly flat and a hole drilled through at a point directly other bar on that side of the arch. Through this hole is screw for pushing, as shown in Figs. 260 and 263. The d not be over ¼ of an inch in length.

pliance is now ready to place in position, as shown in Fig. n position in Fig. 269.

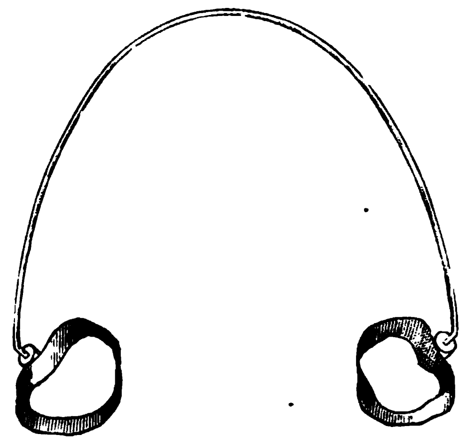
e is exerted by tightening the nut. After the nut has e length of the screw, the bent wire is removed and a little, that the screw may have more action. It will he engraving that *two* of these screws and braces are used, in in position while the other is being straightened, thus the teeth from moving back, as would be the case if but d.

"These braces are moved along the bars forward or backward, according as pressure is needed. After the sides of the arch have been pressed apart the desired distance, they are retained by a straight bar passing across the arch from cuspid to cuspid, the ends being bent sharply at right angles and hooked into little pipes, soldered at right angles to the pipes already described as attached to bands encircling cuspids.

"The incisors are drawn into line by means of the lever and traction screw, this cross-bar serving as the wire of resistance for the traction screw to pull to.

"This method of expansion may be applied to the lower arch as well, as little interference is offered to the movement of the tongue. If several teeth are to be retained in position, one molar on each side of the arch is banded and piped on a line parallel with their axis.

FIG. 270.



Into this pipe is hooked the ends of a piece of the plated wire, bent to conform to the shape of the arch and snugly encircling it. To this wire is attached by bands and pipes such teeth as should be supported. Fig. 270 shows such a retaining appliance.

"Such is the general method of using these three appliances, but the different ways in which they may be applied are almost innumerable, each case requiring some slight modification.

"The greatest care and accuracy should be observed in the construction, application, and use of these appliances. The little tube should be of gold and fit snugly the different parts of the appliances passing through them. The rubber dam should always be adjusted about the teeth before fitting and cementing the bands into position, and the cement used should be of the finest quality. The

be made of platinized gold, or, if of steel, they should
ted."

ILL SYSTEM OF CORRECTORS FOR IRREGULARITIES.

BY W. G. A. BONWILL, D.D.S.

tice to a subject of such vast importance, and do credit
ould demand more space. I shall, therefore, deal more
n of the apparatus and cases, leaving the *new theory of*
s completeness to the near future in a monograph. To
n history more replete, I must show what I did in this
from 1854. My first essay was on orthodontia in 1862,
its length, was not published in the *Cosmos*. As the
s then entirely new and the practice rather radical for
l as it has since been revived by others, I shall briefly

observed that the "Talbot spiral spring" is a true re-
f the figures 271 to 276. These I used for several years,
doned them for the present simple devices shown in figures
Only occasionally I use the spiral spring.
following language it will be seen that I anticipated the
" of rubber, except that I used silver wire made spiral,
em adjustable or detachable from the plate.
nferior jaw, I clasp, where possible, and when not, *strike*
cover the deciduous or permanent teeth, as they may
ate from this. From the inward inclination of the inferior
d molars (or molars alone of the temporary set) there
ient firmness gained by making it to press outward at
"

are no other means of holding, in the inferior jaw, an
plate made to fit accurately either the teeth or palate, or
f you desire, the surface of the vulcanized plate can be
enable the patient to masticate thereon, and screw the
s into this."*
dom used, being bulky and dirty, and far more liable to
ces of the teeth. I could do more with the spiral spring
metal plate.
principles of action I then held I still adhere to, to wit:
mmence as soon as possible after the seventh year, or as
is evidence of decided irregularity.
atch all children's teeth from the third year and deter-
exploring needle every three months, the exact position

om my essay on "Orthodontia" read before Delaware Dental So-
r 1868.

of the coming permanent teeth as soon as the first permanent molar has appeared.

3d. To preserve, by early treatment, the first and second molars—temporary—even to the treatment of their pulps, if they were not brought in time to obviate it.

4th. To be sure the first permanent molars are preserved without loss of pulp and allow nothing to interfere with their full and free development in the arches, as upon these teeth more than any others are due the irregularity, *by coming too far forward in the arch from decay of approximal surfaces of temporary molars, or from the tardy eruption of the permanent incisors.* The sixth-year molar drives the arch into smaller space when the incisors have appeared out of or inside the arch.

If the arch is once interfered with the area is not so great, and consequently there will be a deeper underbite and the permanent molars will move forward and always keep them so, causing the permanent teeth which are yet undeveloped in the maxilla, and lying over each other and not in line, to roll over and shorten the whole maxilla in front of the permanent molar. *Therefore,* keep this tooth as far back toward the ramus as possible.

5th. That all apparatus should be simple and, if possible, firmly fixed, that the patient can have no control over it, and then see the case every few days.

6th. That constant and uninterrupted pressure is preferable. The antagonism of the opposite jaw will always be exerting a force to make them move back and forth in the sockets, which makes sufficient intermittent pressure.

7th. That while one plan, without change somewhat to each case, will not do, yet the infinite number of such apparatus is a greater nuisance to patient and operator.

8th. That impressions of both jaws in plaster and a duplicate from the first; that the plaster teeth could be cut off and rearranged to see the effect, and these models placed in my anatomical articulator, where they could be studied in the lateral movements, so necessary. That this should be studied carefully; and, before action is taken, have the patient call and study the case in relation with the plaster model; and if doubt existed as to the extraction of a tooth or teeth, better postpone a few days and send for patient again rather than make so great a blunder.

9th. That a tooth should be held as sacred as an eye; and, while extraction is sometimes demanded, when the greater good of the patient is at stake—when of weak constitution—yet do not too hastily resort to it.

at without the combined assistance of parent and child, commence.

at nothing should be withheld from the child or parent, but l, every risk, and the amount of patient endurance needed, ne, and, when all is corrected, to allow of stay plates, that ained may be retained.

t least of all the factors, I must mention (which I did not to place such valuation on the services as will insure your l will drive the parties concerned up to their duties.

points I would now further insist on the great importance as factors or fulcrums the temporary molars.

haping them with a disk on all their sides or surfaces, so clasp can be securely placed thereon. Figs. 291 and 292. re a ligature only is needed, to cut a groove with the disk cal and palatal and lingual surfaces near the cervix, in ace the silk ligature to keep it from working down under Fig. 291, C C.

th will soon be lost, and no injury is done by shaping and groov-

the use of gutta-percha (Figs. 280 and 281), warmed and he palatal or lingual side of the tooth, around which a liga- e placed and carried slightly up over the grinding surface the ligature from pressing down under the gum. This I nanent teeth.

ere the tooth cannot be cut or gutta-percha used, then gum varnish or a thin solution of oxyphosphate zinc placed on will prevent the ligature from slipping when the tooth is ed, or to keep it from pressing up under the gum.

immense importance of the Anatomical Articulator, with rical and mechanical laws governing it.

dy of this alone will lead to the anticipation of so many es, and will teach one to commence very early. It shows able is law, and when violated, where the cause is and how it.

what is an *archetype*, and demonstrates clearly how the ciency is reached in the equilateral triangular jaw of man, othing can be made more perfect by nature or man.

make my application of this to orthodontia I must unravel you can see in the *American System of Dentistry*, vol. ii, Presuming upon your having read the article, I will take of it to save time and work and concisely put-it.

e want to get at is the significance of the grinding surfaces uspids and molars with the curve at the ramus and the

particular angle formed by the palatal surfaces of the superior incisors.

We want to know exactly how much the superior incisors should overlap the inferior, and how far up on the palatal surfaces of the superior incisors and cuspids the inferior should go—or the underbite—before we can understand what is a deviation from the normal standard, and how to intelligently correct it.

I have asserted that the length of cusps of the first superior bicuspid governs the whole thing. Give me such tooth from any prehistoric age, and I will tell you how deep the underbite of inferior incisors. It is no guesswork!

You see hundreds of mouths with the inferior incisors going so far up that they touch the base of the superior and in many cases the gums. Why is it not normal? No one can tell without this law governed by the first superior bicuspid.

Every one will assume that the upper should close over the lower incisor, and their only reason for it is because the inferior being smaller in width must form a smaller arch, and must work within the superior arch of large incisors.

There are several other reasons that this model will reveal, and could only be known and seen, first, in it.

Unless there were an underbite, and that regulated to a given depth by the teeth in the rear of the arch, the superior would be thrown so far forward, while the inferior would be thrown inward, as to lose their usefulness and be a deformity, as we so often see when the bicuspids and molars are gone and no antagonizing surfaces are left as abutments. When we look at the curvature at the ramus we are reminded that there is an overbite, for were there no curve just here the muscles would act more forcibly on the side opposite to that upon which you are chewing, and the normal relation of compensation and efficiency would be destroyed.

Then I say the *highest efficiency* cannot be reached, or, in other words, to get the greatest results from the least expenditure of force with least wear to the teeth, except by following this design; and when this is fully realized, you will see where but little change of position of the *first permanent molar* forward, from the extraction of a temporary molar, the normal bite is made much deeper, as it allows the jaws to approach each other very much faster.

If nature intended to have given man a deep underbite, then we would have seen such an arrangement of the back teeth as carnivorous animals, where but one long cusp is used to get the greatest amount of shearing surface.

Instead, then, of the bicuspids having cusps greater than the

equilateral triangle, they would have all been cuspid der that the cusps would be of any value in the lateral When they reach beyond an angle of 45° their efficiency gained, but a direct loss and danger of fracture by the shaped cusps that would have to enter it. A cuspid would ore powerful to pierce and cut, and no danger of loss from

ssert, when the overbite or rather underbite rises higher *hth of an inch* abnormality commences; since the incisors ermit the bicuspids and molars to come into contact when were touching on their edges. But by this arrangement, n what lateral position you place the lower jaw, the teeth ws will be touching at their separate points of the equi- ngle at once.

take a natural superior first bicuspid and measure the s cusps, place it at the point on the two lines *a* and *e* in its distance from the condyles with the superior centrals. This

FIG. 270 *a*.

ut one-fourth the distance from the centrals to the line m the condyles. Do you not now see that if these two *e* diverge from the point of motion at the condyles at T until the superior bicuspid at *b* at the depth of groove, that e lines still further to the left until they strike the palatal he superior incisor, the lines must be further apart there ere else? Fig. 270 *a*.

know exactly, when I am grinding on artificial teeth, that ite at *e* and *a* is one-eighth of an inch, the depth of cusps eeth backward until I reach T would be of less depth, and have no cusp at all.

not true, only certain teeth would touch at any lateral and deeper than this the bicuspids and molars not ut little of the time would throw much more force on surfaces of the upper incisors to press them out of the

arch and contract the arch of inferior incisors and crowd them into a lesser arch as so many bricks, one over the other.

Then you must surely see that the permanent molars must be in a position that their length out of the jaw must be such as to allow the inferior incisors to occupy a larger arch, and only under such plan can they be regular and fill their highest function.

To make the application. If we extract the first temporary molar too soon after the sixth year the second temporary molar will be thrown forward on this scale and on these lines *a*, *e* to T, that will allow the jaws to come closer together and force the inferior incisors further in under the wedge-shaped palatal surfaces of the superior incisors until they begin to overlap each other, since the arch becomes less as they are driven backward by the inclined plane of the palatal surfaces of the superior incisors, and until the first molars again touch on their grinding surfaces, which is only after they have been moved forward between these lines *a* and *e*.

The same result follows should the first permanent molars not come up as fast as do the incisors in the inferior jaw. The latter are in advance, and consequently there is no prop long enough to hold the jaws from a deep underbite or the inferior incisors touching the gum.

Besides, if the inferior permanent incisors should be forced within the arch by non-absorption of the roots of the temporary teeth, they would have no guide from the superior incisors and the result would be too deep an underbite.

Now all this is with the temporary teeth and the first permanent molars at the seventh year.

Should the second temporary molar be extracted too soon, the deformity becomes more marked by the forward movement of the first permanent molar.

Aside from direct loss by extraction, see how much approximal surface is lost on all the temporary molars and on the incisors from caries, which allows the first molar permanent to move forward and the loss of it to keep the jaws apart, at this early age so necessary. Still further is this increased by the rapid decay of the first permanent molars allowing the jaws to approximate still nearer, forcing the lower incisors into a much smaller arch, and consequently higher up under the superior permanent incisors.

Add to all this the crowning climax of blunders: the extraction of the first permanent molar or molars too soon. One is enough to break up the masticating surface on that side, and how great a loss, as the force of mastication is thrown upon the incisors, which, at this early age, must drive the upper out and the lower in and crowd worse than ever.

the straw. See now the condition of the permanent teeth not yet to the surface (bicuspids and cuspids), with a c ch, from the full complement of teeth, but the loss of ma he proper region has prevented the expansion of the arcl necessary at this early age.

none are extracted, look at the many deciduous teeth tl d pain from exposure of pulp and abscesses which preve the jaws on hard food, such as is needed to develop size a e nutrition to the parts to make the processes, but also t on the nutrition of the teeth themselves.

all wonderful that we have increasing abnormality wi f caries?

not see from this pen picture what a grand field we have e destiny of individuals who are certainly doomed to grea as the ages come?

ur duty lies, above all else, in watching each child wi care, making it a part of a *forced* education to go to t ry three months and submit to a close examination with needle to find the coming tooth in advance of looseness a ve your best efforts to the saving of the temporary bef exposed.

ncipal causes of irregularity are diverted and polluted nut trition is *diverted* when the jaws and teeth are not activ ally used, and it is taken up by those organs that g it from their constant action before it can be applied to t *olluted* nutrition is where diseases of various kinds contan uids and render inactive by their poisons the organs as gular deposits of bone in the teeth and maxilla, retardi th, consequently their arrangement in the arch.

ice of proper food and its mastication has a powerful eff diminishing the supply of phosphates but their applicati and teeth from want of proper action.

eminus nerve is not a factor.

nutrition by perversion, pollution, or diversion be what he factor in the cause of irregularities, let us draw upon o n the first effort that nature makes to supplant the tem The first permanent molar in both jaws should be prese eir full height or place, or in contact before the cent e lost.

ecay of the temporary teeth is potent in irregularities. T use of the forceps by too early or late extraction, acciden east, the meddlesome dentist. We find it almost entir civilized life. Never found in the lower animals.

scles are becoming, or should be, stronger every day, as t

most active parts gain the most nutrition and at once. Unless the teeth are in full contact and well propped in position by alveolar borders calculated to resist the coming force to be exerted thereon, the arches in front, being now the weaker of all, must be forced out of position by the jaws being forced nearer each other. This is most possible, for if nutrition has not been plentiful and not used greedily by the alveolar processes, the results must be as I say.

Then look at the average set of teeth of the child at six that comes to us. The further the sixth year molar goes forward between these two lines *a*, *e*, and T, the less room all the coming permanent teeth have, and, the jaws necessarily coming closer together than if the molars had remained at their place in the alveolar border, where the greatest resistance is offered, we can see how the bicuspids are rolling over each other and in the circle or arch in front where the teeth are in advance in the lower jaw, but not growing as fast as they should from want of nutrition by perversion or pollution, the props—the temporary incisors—being no longer of value, the jaws approximate too closely, and when the laterals make their appearance is it any surprise to us that they should be inside the arch in most cases? How could they arrange themselves regularly when the arch is so wanting in firm bone to hold them in bounds, and from caries of all the posterior teeth and those not yet above the surface crowding forward as the resistance is taken away from the condition of the temporary molars and lack of energy in the tissues, both soft and bony? It would be marvelous if they in their normal state, which is apparently not in curve, should not be found one upon the other, overlapping in the border before eruption.

To add to the horror, the irregularity of their periodicity is so great and out of order or proportion that the inferior permanent incisors are crowded into a smaller arch than the third of a circle, and there is not room for them. The malady increases as the incisors of both jaws come into place. If any irregularity at all in the superior jaw, it becomes greater in the lower, for as the inferior reach the normal point, where they should stop going up under the superior on the palatal side, they fail to do so for want of that proper resistance which a perfect arch alone in the lower would insure.

But one tooth inside the arch of the lower jaw and at once, as the superior come into place later from requiring more nutrition and want of full use from the pain of mastication, they are retarded, and the lower arch becomes smaller than the third of the circle, and, as a sequence, are crowded by the superior inward and upward until in so many instances they reach the gums at the base of the superior incisors, because, as I said previously, the lower arch had collapsed from the many causes which should have been prevented.

occur in jaws where the temporary are in perfect condi- l as the sixth year molars, from a contracted alveolar absorption not keeping time with the advance teeth. so often found.

contracted jaws from extraction and caries, it is compressed ders, and the want of resistance in them when the mandi- cannot be performed and no healthy nutrition be the is the condition of the parts.

k the first permanent molars, and, if possible, push them toward the condyles, that there may be no intrusion on of the coming permanent teeth. Have the temporary condition that free mastication can be performed. Give the nutritious food he needs, with plenty of exercise and p saccharine matter far from him in the shape of cake and ke him eat his food without any water or drink. Have glands of value by compelling them to secrete from the ood, and food will be sweet enough without sugar. The longer in the mouth. The jaws are used their full time. become stronger and the alveolar borders firmer, and the plentiful and is utilized without any part having to cry at of it. The nutritious supply will then always be in the demand, and well laden with everything that can an organism, and my word for it, good teeth and a well- outh result.

d the greatest satisfaction in the use of gutta-percha on nal surfaces of the temporary molars, which, as long as it in them, spreads the jaws or keeps the permanent molars ng forward. Invaluable.

le has always been how to get hold of any of the tempo- s a fulcrum.

n my practice for years to first make use of the silk liga- bber bands, without plates. To do so, how shall I prevent from slipping off the permanent tooth, and from slipping he temporary tooth used as the fulcrum?

hat as the temporary cuspids and first molars will soon be ne permanent lateral incisors have come, and are high et hold of, to cut a slot with a small hard-rubber disk on and palatal surfaces deep enough to hold the ligature it from ever passing down under the gum, Fig. 291. If I a plate of rubber or metal for the inside I use the same old the plate in position.

have a clasp, which is now most frequently the case in his new appliance, which I will presently show you, I cut

the first temporary molar on its mesial and distal surfaces a little under parallel, as at Fig. 292, and the strain is so slight it is not uplifted before the lateral incisor has been drawn into the circle. If there is any danger from the ligature wounding the gum, I place underneath gutta-percha. If I want to pass a ligature around a permanent tooth (Figs. 281 and 286), as a fulcrum, I simply warm a small piece of gutta-percha and press it on the palatal or lingual side of the tooth, letting it extend slightly down on the gum, and when cold and rigid cut two holes through it to let the ligature pass, and then between the teeth, and tied outside to the rubber band. This little adjunct cannot be overpraised, for it is so soon adjusted, is pleasant to the patient, and non-irritating to the tissues. I cannot tell you how much I love gutta-percha, and especially just here to save me so much plate work and irritation, and for keeping my children in good humor. If a metal wire or band is pressing into the gums, and a hook cannot be used on the grinding surface, the gutta-percha fills the need; and it answers well as a fulcrum by letting the band directly

FIG. 271.

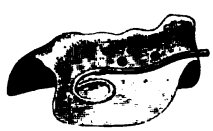


FIG. 272.

into the gutta-percha or by attaching it to the wire or silk ligature that holds the former.

The figures from 271 to 292 show all the appliances and their applications for irregularities. Figs. 271 to 276 show the spiral spring in various phases.

Fig. 271 is a silver plate to fit the lower incisors tied on to a central to correct a superior central from the inclined projection on the right, and the end of spring acting on the right inferior central to throw it out of the arch.

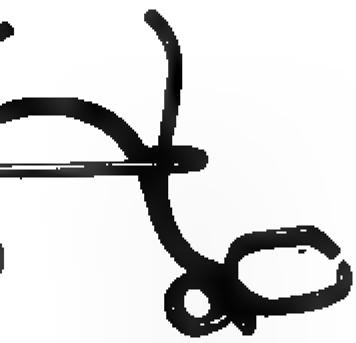
Figs. 272, 273, 274 are metal bands with clasps, with the spiral spring soft-soldered under a metal loop hard-soldered to the band. This retains the temper. These are used on many teeth in either jaw.

Fig. 274 is a metal plate with half clasps fitted to the bicuspids to hold it in position. The spiral spring is soft-soldered to plate. This can be changed to various positions on plate, and is applicable to cases where it is difficult to place clasp entirely around a tooth.

Fig. 275 was made for drawing backward the four incisors of in-

vith spiral springs, adjusted not to interfere with the tongue
teeth. The piece at A goes over the incisors and is held
tied to one or more of the teeth.

FIG. 273. FIG. 274.

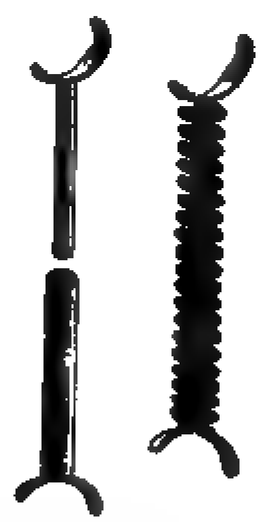


is a jack-spring for constant pressure. It may be made in
conform to the hard palate. It is very powerful and
d superior to a *jack-screw.*

ese spiral-spring appliances the spring is tied to the tooth
upon to hold it from slipping; or, in some cases, a hole
the tooth is better.

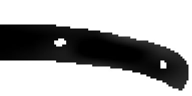
FIG. 275.

FIG. 276.



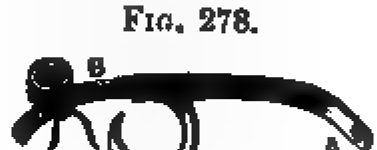
liances that with me have superseded all others are seen
7 to 292. Fig. 277 is a curved bar of platinized gold with
punched therein for the passage of silk ligatures. It is

. 277.



in Fig. 285.

FIG. 278.



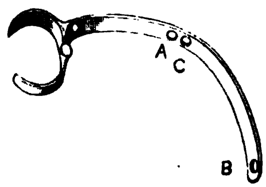
Applied in Fig. 289.

y of applying Fig. 278 without band and used mostly for
ooth in either jaw. The principle of action will be seen
5, where two inferior lateral incisors are to be drawn from

within out. To do so requires expansion of the jaws. This is effected by making the holes in the end of the plate over the centre of each cuspid and by carrying the silk ligature from the mesial side of the laterals around back and up between the lateral and cuspid and through the hole in plate at either end, and attached to a rubber band which is stretched between the holes. This pushes the cuspids backward or opens the arch, and the centrals move forward somewhat, and the laterals easily fill the breach. Once in position and they are retained without apparatus.

If the holes through which the ligatures pass were made exactly opposite laterals, no good would be effected, because the pressure would be as much down as out, and compressing the arch. But the ligatures applied as directed force the jaws apart, although the band is resting hard on the cuspids. The ligature is a loop or slip-knot, and must be applied so as to come out between the lateral and cuspid. Gum sandarach varnish will keep it from slipping around

FIG. 279.



Bar shown as applied, Fig. 281.

FIG. 280.

Applied in Figs. 281 and 286.

the tooth. The band, as heretofore applied, has not expanded the arches, because the holes were not in the right places—over the cuspids.

Fig. 278 is this same bar with a clasp on one side of the arch. The bar is lengthened beyond the clasp to allow of the *rubber tubing tied at* B being attached far enough away from A for getting power.

It is applied, Fig. 289, by clasping a first molar. The right central has to be twisted and the lateral also, but in the opposite direction. The bar rests upon the mesial buccal edge of the lateral while the silk ligature is carried *twice* around the central, bringing it up next the lateral and over it through the hole in the bar in the point where it rests on the lateral and is now drawn through the rubber band which has been tied opposite the molar. The rubber is stretched to the full length of the bar. The cuspid was also drawn outward on the same bar by boring a hole directly opposite, which can be made to twist the cuspid as well as to draw it outward.

Fig. 279 is the same bar applied to Fig. 281 for drawing out both

rals and expanding the arch. The right cuspid is j
d the first bicuspid is clasped. The ligature with a sl
d over the right lateral, coming up from its distal s
the hole in bar at A, and tied to the rubber band n
uspid. The left lateral is ligated the same way, comi
he hole at B, which is over the centre of cuspid. T
sing the left cuspid backward is tied to the rubber ba
e the bar is too short to stretch the rubber band, it c
d on one side of the clasp or carried back to the rig

jaw partially shows the application of the gutta-perc
e Fig. 280) for keeping the ligature from off the gum

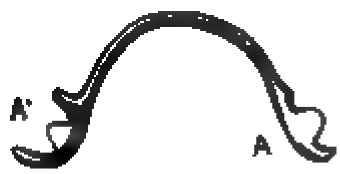
Fig. 281.

e first molar. The lower jaw being too large an ar
r, I extracted the first right bicuspid, and as the rig
or incisor was too far in the arch, and the right cusp
ide, I simply ligated the first inferior molar on the sa
ce of pink base-plate gutta-percha was warmed a
ainst the molar, letting it rest partially on the adjo
e Fig. 280); when cold, two holes were made in it
of the ligature, which was tied on the buccal surface
A rubber band was tied to the inside before adjusti
now cast around the right lateral, carried up betwe
spid, and over it through the space where first bicus
d, on the lingual side of the first bicuspid, and tied
and attached to the gutta-percha stay or helmet on
and stretched over the buccal surface of the cusp
he lateral out very forcibly. The ligature was las

placed on the cuspid alone, and remained for six weeks without change.

Fig. 280 is also applied in Fig. 286. This was a very contracted lower arch with a deep underbite. The arch was first expanded by the fixture shown in Fig. 282, made of piano wire, with half clasps

Fig. 282.



Applied to Fig. 286.—Expander of bicuspids, Lower.

Fig. 283.

Shown as applied, Fig. 284.

of platinized gold at A A, made with small ears to rest on the grinding surfaces of the first bicuspids to prevent slipping down upon the gums. These clasps are soft-soldered to retain the full temper of the piano wire as a spring. It is a very cheap and easy way of making such an apparatus and with a powerful spring, which such cases demand.

Fig. 284.

In this case I could not afford to extract any teeth, because the incisors were already touching the gums on palatal side of the superior centrals. In expanding the lower arch I obviated this deep over and underbite. The left lateral was very far inside the arch, and the cuspid so far as to nearly allow the bicuspid to touch the

e silk ligature was now placed over the lateral and next the cuspid. The first bicuspid was ligated with a r helmet of gutta-percha on its lingual side, with the ning through both holes and carried around the first l tied on buccal side. This prevented entirely the slipure upon the cervix. A rubber band was now stretched lateral and bicuspid and secured. This expanded the t and drew out the lateral in a very short time. Had ce for a broken or slipping ligature. These little guttaor helmets work admirably and are not worn or displaced n.

s another modification of Fig. 279, or single bar, and is Fig. 284, where the four superior incisors are to be moved n one-fourth to three-eighths of an inch and the whole

FIG. 285.

ed to meet the more perfect and larger arch in the s made of two flat bars of platinized gold sliding over for at least two (2) inches. A loop is soldered to the flat bar as guides to hold them in place while sliding rubber band is shown attached to the end of each bar ch, in contracting, enlarges the circle and consequently rows out the incisors, but the bicuspids and cuspids as

ments are made on either side to a molar or bicuspid, ease of clasping. I have utilized the decay on anterior molar by filling with amalgam and cutting a hole into it of the bar to rest, instead of a clasp.

atus is shown applied in Fig. 284, with the bars some disfrom the incisors to be attacked.

apparatus is placed permanently in position the four ligated with a loop, as shown in Fig. 291, using gum

sandarach varnish, to prevent slipping or turning on the tooth. The ligature should be so adjusted as to twist the tooth if needed while drawing it forward. These are now tied to the sliding bars, bringing them closely in contact with all the teeth in the arch. The rubber band is now tied between the two points A A, and the application is complete. It is easy to see not only its simplicity but its great effectiveness. It can be used equally well for contracting an arch.

Fig. 286.

Fig. 287 shows the worst case of protrusion of the upper jaw I ever saw. It was not done by an acquired habit, nor did it have any precedence in heredity. The temporary teeth had proper arches. No

Fig. 287.

cause could be assigned. They came as you see in Fig. 287. The lower incisors, when I first saw the case, were three-eighths of an inch from the superior incisors on their palatal surface, and were imbedded into the gums on the hard palate.

empting to draw in the incisors I made a rubber plate cover the hard palate, thickened where the lower teeth and opened the jaws at the bicuspids at least one-inch. This was not only to drive the inferior incisors

Fig. 288.

to their sockets, but to allow the bicuspids and molars to nd antagonize before the plate was removed.

were consumed in this. To this plate I now attached a carried entirely around the arch with a silk ligature,

Fig. 289.

ntral incisors I made a metal hook, carried over their with two holes, through which the ligature passed. This ture down on the incisors near the cutting edges, and aiding in drawing in the arch it did another important

thing: forced the centrals up into the alveolus. This was done by the tendency of the rubber band to work up toward the gums, and at the same time it pressed them up and made them shorter without grinding. This was a parallel case with the one delineated by Dr. Kingsley in "Oral Deformities," but without any of the treatment given there. The sliding band in Fig. 283 would have done well here, but I adopted the simpler one of ligature and rubber. To secure it a gold band running over the arch from the second bicuspids, which were soldered to clasps around the latter, which could be adjusted or removed by patient.

The rubber plate was removed as soon as I commenced to draw the incisors into the arch, to give room for them to fill a smaller arch. Fig. 290 shows the application of the band in the lower jaw, where

FIG. 290.

the temporary molars are still in place. The permanent laterals are far inside the arch. The temporary cuspids also remained. The first molar has had all its sides squared to retain a clasp. A platinized gold bar, similar to Fig. 279, with clasps, is used, with a hole at the end of bar C; and then opposite the right central incisor, with another over the centre of the right temporary cuspid at G, and the fourth hole at the end of bar near the first molars at B.

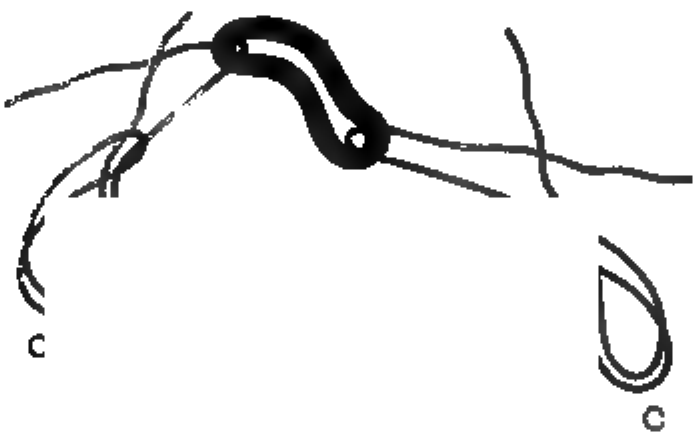
The principal feature about this is, aside from the bar, the cutting so heroically the temporary molars for retaining the plate. This does no injury, and if it was likely to, they would soon have to be extracted for the bicuspids.

The ligatures are applied as in all former cases of this bar, so as to press backward as well as drawing outward. In this case two separate pieces of rubber band are used.

Fig. 291. The feature about this case which makes it novel and unique is the utilization of the superior temporary cuspids for holding the ligature. To place a ligature on the temporay teeth

r removal or extraction without this plan. It is to keep on the body of the tooth I take a small hard-rubber corun- nd make a groove on both the labial and palatal sides of deep enough for the ligature to rest securely. If necessary, it to the first or second temporary molars, if a ligature tten around the incisor to be turned into place.

FIG. 291.



er band is drawn through and between the centrals, which e power over the incisors. The left superior lateral was in the arch.

shows the cut surface in first temporary molar on the left ied on the right with the clasp around it attached to the

FIG. 292.

igature passes between lateral, over central, and through at A, pressing central to the left and molar to right.

peat—the utilizing of the temporary molars in cutting them , or by grooving for ligatures, cannot be over-estimated. f fulcrums early in the case, which heretofore baffled our sooner we commence to correct irregularity the easier and ete.

The explanation of geometrical law, and the value of the anatomical articulation in showing how the first permanent molar plays so important a part in making the lower incisors roll over each other, and make a smaller arch and with so deep an under- and overbite of three-eighths of an inch, as to destroy the pure law of one-eighth of an inch as the normal one. I am almost quite ready to say, *never* extract the first permanent molar. Keep down the inferior incisors. Have the permanent molar take its place soon and rapidly in the arch. Drive it backward toward the ramus rather than have it move forward to make the underbite too deep.

To a mind of any comprehension these are simple devices and plain rules; the application can be made to any case of irregularity. Any one can surely make the apparatus. Whoever hereafter will undertake this branch of practice, should first read my article on the geometrical law of articulation, and study the principles involved, and not attempt wildly to do what but few men have even truly fathomed. Really, in every city some one should make of this a special practice, and the profession should encourage such by sending cases for their inspection and consultation. And such specialist should do all he can in return, to teach by example and demonstration by clinic, to enlighten those who are so placed from large cities they are compelled to take such cases. When we can have that understanding between us, then we may feel as banded brothers more fully equipped for these hitherto difficult and almost thankless operations.

In conclusion, to sum up briefly, do not interfere where by simple extraction the case will correct itself; when teeth must be moved, do it decidedly, to avoid tedious delay; but take care not to be so rapid as to excite inflammation; do not move teeth with deformed or defective roots; do not sacrifice sound and regular bicuspids to bring into the arch teeth which will require to be moved through a great space, for this movement materially impairs their durability; lastly, do not attempt to bring teeth to a position where you cannot keep them until firm ossific deposit makes them permanent in their new positions.

Dr. Kingsley is of the opinion that a correct judgment can rarely be formed of the proper treatment necessary in any case of irregularity which necessitates a change in the expression of the mouth, from plaster models alone, as an opinion formed by the most experienced observer on a cursory examination may be changed upon a more careful study of the features, the family type, and the model of the teeth. The same writer remarks: "It is not always advisable

to change the expression of a mouth where the condit
rited peculiarity, a part of the family type, and where
ould involve a very prolonged effort, possible breaking u
rticulation of masticating organs, and with the knowle
e will be constantly making an effort to return to the her
"

CHAPTER II.

TREATMENT OF DENTAL CARIES.

atment of dental caries is one of the most important ope
dental surgery, because of the usefulness of the organs
the universality of the disease, also the complex
ature of the treatment required. The caries may be sli
ficial, or it may be more or less deep-seated; lastly, it m
even to the pulp-cavity. The difficulties of treatment
the same order, and in this order they will be taken
en superficial, may be arrested by the same means u
caries; but in a large number of cases it will require
al only the use of files, enamel chisels, or disks. Th
s are also often used preparatory to the operations necess
est of deep-seated caries; hence their use demands our fi
ion.

ENT OF SUPERFICIAL CARIES.—There is no operation
gery against which a stronger or more universal prejud
han that of filing the teeth, yet, when judiciously a
performed, there is no one more beneficial or effectual
the progress of caries. Although productive of mu
in the hands of unskillful operators, a source of incalcula

n Harris says:* "Filing the teeth is one of the most i
d valuable resources of the dental art; it is one that
test of experience, and is of such acknowledged util
itute of itself, in the treatment of superficial caries on t
faces of the teeth, one of the most valuable operatio
be performed on these organs. And even after caries
ies just mentioned has progressed so far as to render
y this means impracticable or improper, the use of t

marks are applicable to all instruments employed for the same p
file, such as enamel chisels, corundum and diamond disks, etc., e

file, in most cases, is still necessary in order to the successful employment of other remedial agents. But in either case a failure to accomplish the object for which it is used would only be equivalent to doing nothing at all.

"The use of the file, then, may very justly be considered a *sine qua non* for the removal of superficial caries from the sides of the teeth which come in contact with each other, as can be attested by thousands of living witnesses, and in preparing the way, in deep-seated caries, for the thorough removal of the disease and filling successfully the cavity thus formed.

"The fact that the crowns of the teeth are covered with enamel is alone sufficient evidence of its importance and utility in shielding and protecting the bony structure which it envelops from mechanical and morbid influences, so that it would seem that its removal or loss would necessarily expose the organs to certain destruction. But we have satisfactory evidence that teeth, after having suffered the loss of large portions of the enamel, have been restored to health and preserved for many years, and often through life.

"The rapidity with which caries progresses after the exposure of the dentine by the loss of the enamel depends upon the physical peculiarities of the teeth and upon local and constitutional influences; hence the difficulty, and oftentimes impossibility, of obtaining the object for which dental operations are instituted while such influences are suffered to exist. If special regard is not had to the curative indications, most, if not all, the operations upon the teeth which have for their object their ultimate preservation are sure, to a greater or less extent, to augment all of the previously existing local affections, by increasing the irritability of the parts and by rendering them more susceptible of being acted upon both by local and constitutional causes.

"There is no instrument so well adapted as the file for the removal of the disease when situated in these parts of the teeth, especially when the organs are in close proximity with each other; or for the removal of rough and weakened edges of the enamel in deep-seated caries, and for making sufficient space or room for the removal of the diseased parts preparatory to plugging.

"It may be laid down as a rule, from which exceptions should never be taken, that the file should not be used while the teeth or their contiguous parts are suffering general or local, acute or chronic, inflammation. Therefore, when this is the case, the treatment of the general and local affections should precede the operation of filing. Upon the removal of all the acute or chronic diseases of the mouth greatly depends the success of the dentist in the treatment

ons of the teeth calling for the employment of the file. importance, therefore, is to be attached to an enlightened iminating judgment as to tact in the performance of the .

ct, the removal of all local causes of irritation—such as dead eeth, teeth occasioning alveolar abscesses, or such as exert a nfluence upon the surrounding parts, and all depositions of calculus or other foreign matter—should precede all other s upon these organs.

ength of time necessary for the restoration of the parts con- the teeth may vary from a few days or weeks to as many depending upon the nature and extent of the disease, the ealth of the patient, and the constitutional as well as local to which they are subjected.

suming the position that filing the teeth does not of neces- them to decay, it is by no means to be inferred that the can, in all cases and under all circumstances, be per- with advantage or even impunity. Its effects, like those of r operations upon the teeth, when the curative indications garded or not properly carried out, are most injurious. oyment of the file at an improper time and in an improper ncreases the liability of teeth to decay; it augments the y of all the parts adjacent to them, and consequently ceptibility of being acted upon by local and constitutional

ithstanding the utility and value of the operation, filing the be regarded as a predisposing cause of caries. If this be ay be asked, Why file at all? I answer, in this country, the prevalence of the immediate or direct cause of caries, ation is only performed as remedial, for the purpose of actual disease or as preparatory to plugging. It does not ty follow that caries of the teeth, after having been judi- emoved or treated, although the organs be predisposed to e, will ever again occur. The general system often escapes opment of those diseases to which it is predisposed through lso do the teeth. If the operation be properly performed filed surfaces kept thoroughly clean, a recurrence of the notwithstanding the increased predisposition thus induced, r take place. The immediate cause of dental caries being ct of corrosive agents with the teeth, the necessity for this n is obvious. The bony structure of these organs is more ed upon by such causes than the enamel; for this reason, becomes necessary to expose it with a file for the removal

of disease, it should be done in such a way as to admit of its being kept thoroughly and constantly clean, so that if it afterwards becomes carious, it will be owing altogether to inattention of the patient. In view of this, whenever it becomes necessary to file the teeth, whether for the complete removal of caries or as only preparatory to plugging, we should always impress upon the patient the importance of cleansing the surfaces thus operated upon at least three or four times every day. The future preservation of the organs will depend upon the constant and regular observance of this precaution, especially when they are of a soft or chalky texture, for they are then far more easily acted upon by decomposing agents than when hard.

"The cases requiring the use of the file vary so much that it would be difficult to lay down precise directions with regard to the extent to which the operation should be carried. This must be determined by the judgment of the operator. The design of the operation may be defeated either by filing too much or too little. Either extreme should be avoided; but it is my opinion that by far the greater number of unsuccessful results are attributable rather to the too moderate than to the too great use of this instrument, especially where the circumstances of the case have nothing to do in determining the result."

In filing the front teeth and those on the right side of the mouth, the operator should stand to the right and a little behind the patient, in order to steady the head, as it rests against the back of the operating chair, with his left arm, while with the fingers of the left hand the lips are raised and the teeth properly exposed for the operation. In filing the teeth on the left side of the mouth it may be necessary for the operator to stand upon the left side of his patient. The file, firmly grasped between the thumb and middle finger of the right hand, with the end of the forefinger resting upon its outer end, should be moved backward and forward in a direct line, as any deviation from this would immediately snap the instrument. The first opening between the teeth, when the approximal edges of the two are carious, should be made with a flat file about one-fourth of a line in thickness, cut on both sides and both edges; this done, a file cut on one side and both edges should be employed for the completion of the operation. If only one tooth is decayed the operation may be commenced and completed with a safe-sided file. The file, during the operation, should be frequently dipped in tepid water to prevent it becoming heated or clogged while in use; especially should the water be warm or tepid where the teeth are sensitive.

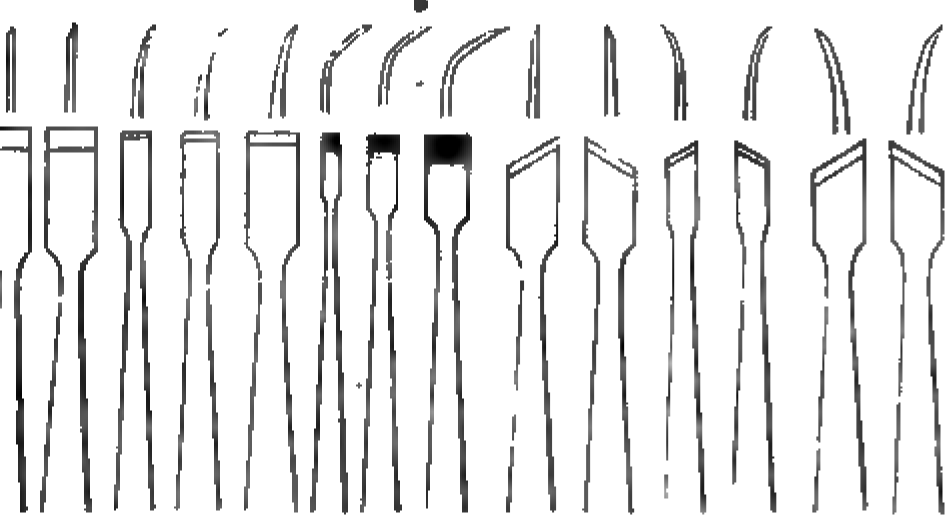
files become so much clogged that the water or a brush eanse them, a brass or steel scratch-brush may be used, or be dipped in sulchlorhydric acid, washed with the care, to remove e of acid.

FIG. 293.

3 represents various of the thin sepa.

re the success of tion it is someessary to cut away a considerable portion of the tooth; but this the operator should be careful not to destroy the sym- the labial surface. The aperture anteriorly should only nough to admit of a free oblique or diagonal motion of a file of about one-fourth of a line in thickness, or a corre- y thin corundum disk. In this way one-fourth or more of a be removed without materially altering its external appear- t a tooth should not be filed entirely to the gum; a shoul-

FIG. 294.



l be left, to prevent its approximation to the adjoining tooth. the decay is of such size and so situated that it may be by means of enamel chisels with less alteration in the exter- bial surface of the tooth. These very valuable instruments be found useful for rapid cutting preparatory to the slower the file. A rounded form can be given by them to the inner the teeth, for which purpose they may either follow or take of the file.

4 represents a set of enamel chisels, straight and curved, by operation of removing a portion of the crown of a tooth

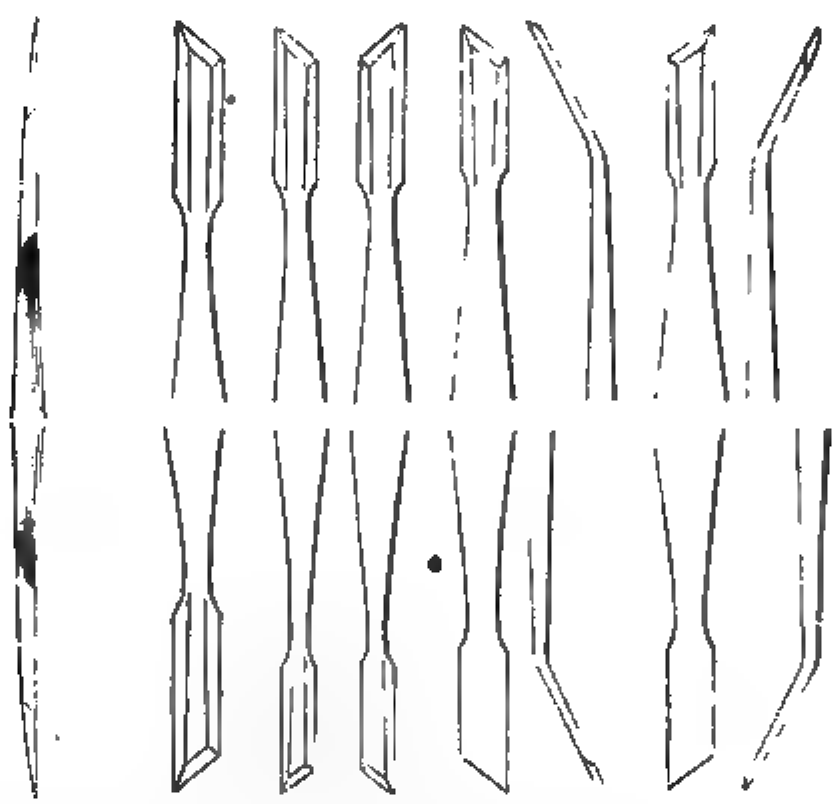
can be performed much more rapidly than by the file, and also with more comfort to the patient.

Fig. 295 represents a set of Dr. Louis Jack's Double-end Enamel Chisels.

Fig. 296 represents Dr. W. W. Evans's set of Enamel Chisels.

When operating upon the front teeth with the enamel chisel, the instrument should be firmly grasped in the hand, near to its cutting edge, and the edge applied to the surface of the portion to be removed,

Fig. 295.



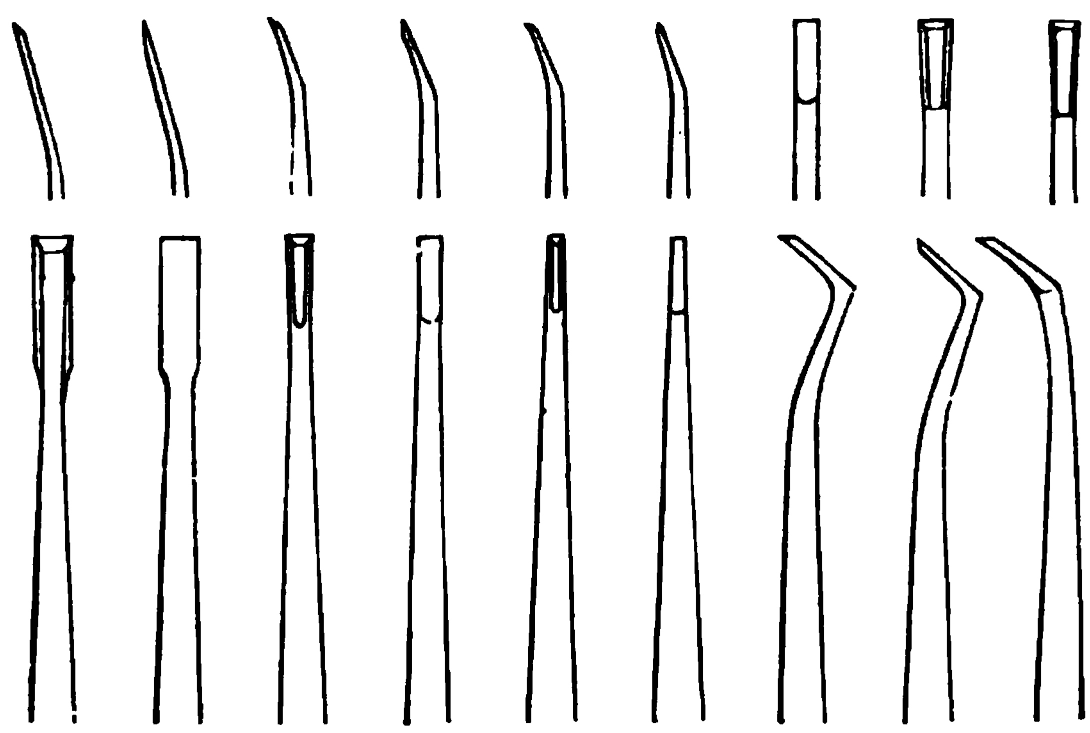
while at the same time the point of the thumb uses as a fulcrum the cutting edge of the tooth or the one adjoining.

For operating upon the bicuspid and molar teeth, heavier enamel chisels are required than in the case of the front teeth, and with either straight or oblique cutting edges. The curved form of chisel is useful when the mouth is small and it is difficult to reach the point desired with the straight form.

When the decay occupies a large portion of the approximal surface and has penetrated into the tooth to a considerable depth, destroying the enamel anteriorly and causing it to present a ragged and uneven edge, it will be necessary to form a wider exterior aperture than mere regard for appearance would dictate. When the approximal surfaces of the two front teeth are affected with caries, about an equal portion should, if circumstances permit and it is necessary to cut away tooth substance, be filed or cut from each

tooth. In the case of delicate front teeth, or teeth slightly loose in their cavities, it will be well before filing to mould a small piece of gutta-percha or modeling composition around or against the inner surfaces of the tooth to be filed and several adjoining ones. It gives support to frail teeth, and greatly lessens the danger of irritation from the motion imparted by the file to the teeth which are not firmly set in their sockets. Some use for this purpose plaster; but we think

FIG. 296.



the gutta-percha or modeling composition, as suggested by Prof. Gorgas, will be found altogether more conveniently applied and more agreeable to the patient.

When the file is employed for separating the superior incisors and cuspids, the operation may be completed with a bevel-edged file, as no sharp angle should be left near the gum.

In separating the bicuspids by filing, a space should be made somewhat in the form of the letter **V**; it should not, however, form an acute angle at the gum. This space should also be slightly wider toward the palatal and lingual surfaces. For its formation a **V**-shaped file, which is one beveled on both sides, will be found most suitable. A space shaped in this manner will prevent the approximation of the sides of the teeth, and if filling be necessary, it will enable the operator to do it in the most perfect manner.

Fig. 297 represents knife-edge or bicuspid-pointed and blunt files.

Fig. 298 represents a file designed by Dr. E. Parmly Brown for contouring the approximal surfaces of molars and bicuspids. It is three-sided and cut on all sides.

When the separation of the molar teeth in this manner becomes necessary the same shaped space should be formed. But as these teeth are situated far back in the mouth, it cannot often be done with

can be performed much more rapidly than by the file, and also with more comfort to the patient.

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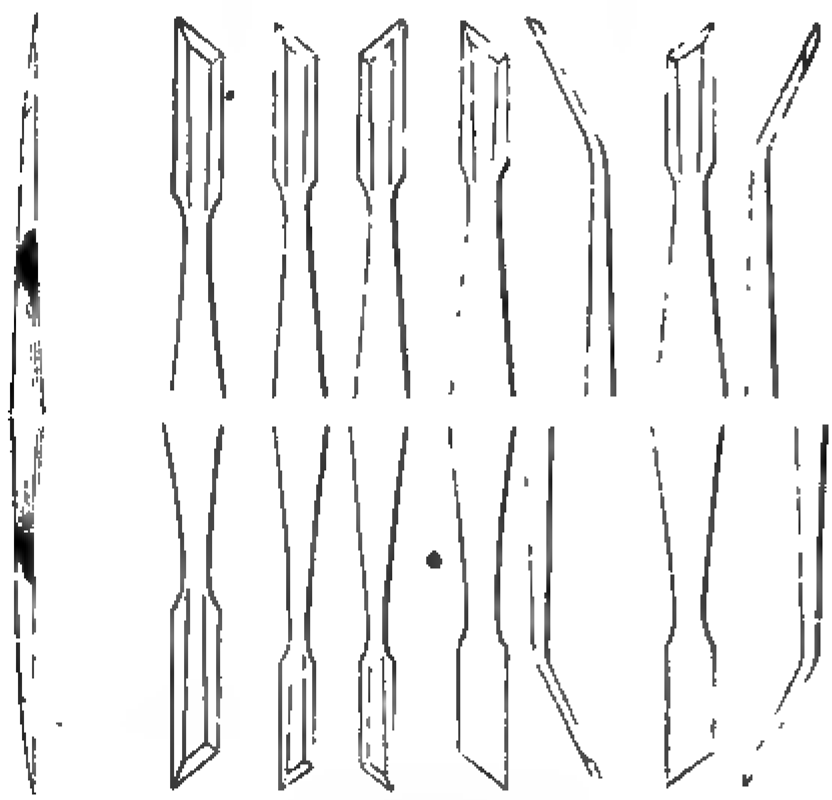
FIG. 295.



while at the same time the point of the thumb uses as a fulcrum the cutting edge of the tooth or the one adjoining.

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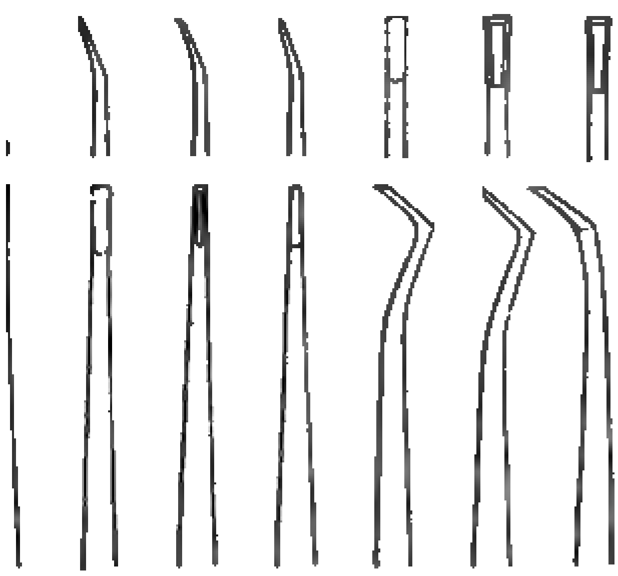
me use for this purpose plaster; but we think

Fig. 296.



leling composition, as suggested by Prof. Gor-
gether more conveniently applied and more

ployed for separating the superior incisors and
ay be completed with a bevel-edged file, as no
ft near the gum.
ispids by filing, a space should be made some-
letter V; it should not, however, form an
This space should also be slightly wider
ingual surfaces. For its formation a V-shaped
d on both sides, will be found most suitable.
nanner will prevent the approximation of the
f filling be necessary, it will enable the opera-
perfect manner.
nife-edge or bicuspid-pointed and blunt files.
file designed by Dr. E. Parmly Brown for
mal surfaces of molars and bicuspids. It is
ll sides.
of the molar teeth in this manner becomes
ped space should be formed. But as these
ek in the mouth, it cannot often be done with

a straight file; to obviate this difficulty, an instrument with which every dentist is acquainted, denominated a file-carrier, is usually employed.

Fig. 297.

Fig. 298.

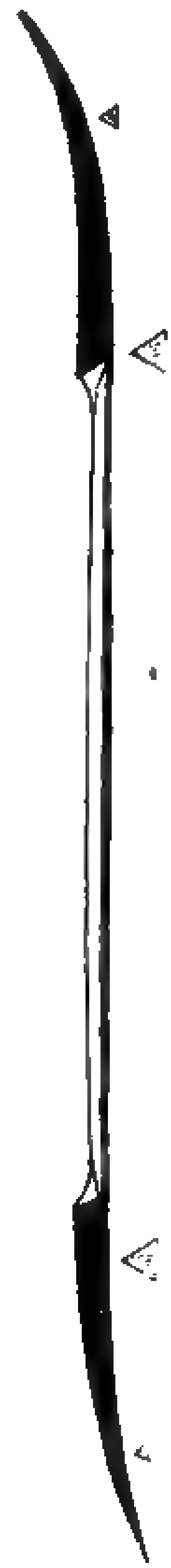


Fig. 299.

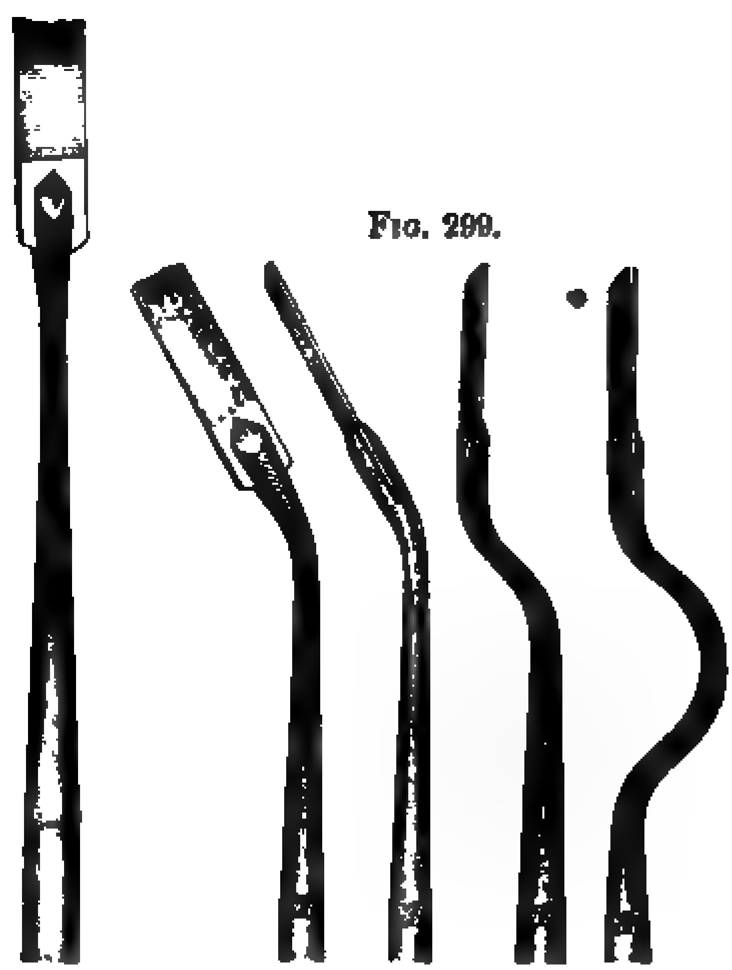


Fig. 299 represents Dr. J. E. Line's file-carrier, which is simple in its construction as well as very serviceable.

Fig. 300 represents Dr. W. B. Miller's file-carrier, with three heads, as shown, which admits of changing direction and slant very quickly.

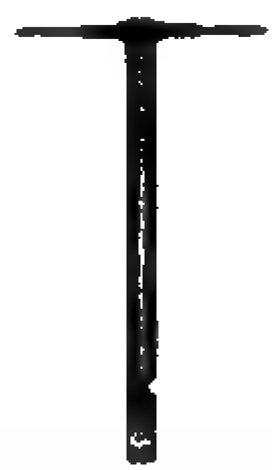
Fig. 301 represents a cheap and simple file-carrier, the device of Dr. D. M. Clapp, either straight or curved, which will carry a thin separating file, and also finer ones for cutting metal.

A file-carrier attachment for use with the dental engine has also been devised, but it is not so readily controlled as the hand instrument.

A great variety of V-shaped separating files are now to be found in the dental depots, from English, French, and American manufacturers. Fig. 302 will give a correct idea of some of these shapes.

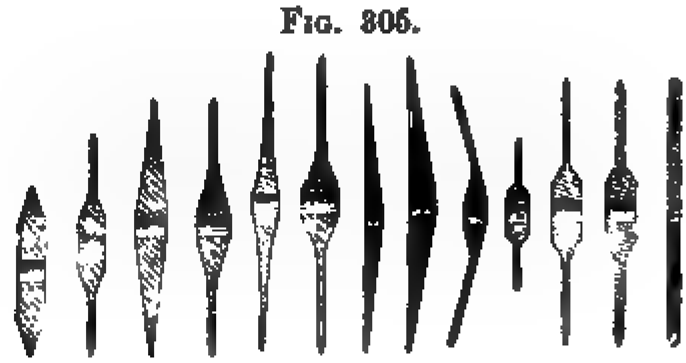
FIG. 303.

FIG. 304.



Disks composed of different substances, and attached to mandrels, for use with the dental engine, are employed for separating teeth that are affected with superficial caries on their proximate surfaces. Figs. 303 and 304 represent the diamond disk, composed of a thin plate of metal, such as nickel, in which diamond powder is thor-

FIG. 305.



oughly incorporated. The corundum disks, Fig. 305, introduced by the late Dr. Robert Arthur, of Baltimore, are now used, to the almost entire exclusion of files, in separating teeth, especially *molars and bicuspids.* Although often employed for separating the incisor teeth, they are not so well adapted for such delicate operations, on account

ntrolled than the chisel or file. The incisor ller than the posterior teeth, should never be tion. When the disk is used for separating the test care should be exercised to avoid too much he labial angles.

lar in composition to the ordinary corundum ing porcelain teeth, being composed of emery c, which, being softened by heat, is rolled into

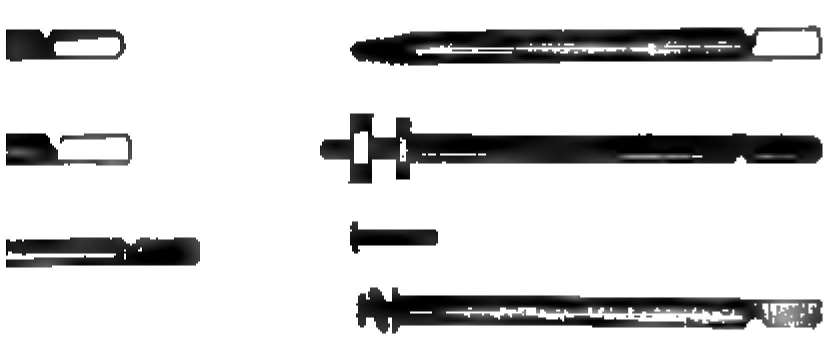
FIG. 306.

es to suit the different operations to be per- disks thus formed are mounted on mandrels h the dental engine, an instrument which will

a few forms of Dr. A. L. Northrop's corundum polishing.

different forms of mandrels, with and without g corundum, diamond, rubber, celluloid, box- sand-paper, and cuttle-fish paper disks and

FIG. 307.



rtion of the tooth has been cut away the surface ooth as possible, with a very fine or half-worn s, Hindostan or Scotch stones, wood polishing r hard rubber, boxwood, felt, emery, sand or ing powders such as pumice, silex, emery, buck- , Hindostan, Arkansas, etc., etc., or with tape ders.

Fig. 308 represents hard rubber disks for carrying powders for polishing the natural teeth and finishing fillings.

Fig. 309 represents boxwood disks.

Fig. 310 represents corrugated soft rubber disks and points for carrying powders for polishing.

Fig. 311 represents emery, sand and cuttle-fish paper disks.

FIG. 308.

FIG. 309.

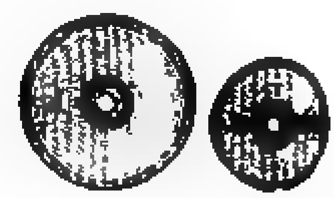


Fig. 312 represents points of Arkansas, Hindostan and Scotch stones, mounted on mandrels, for polishing the natural teeth and fillings.

FIG. 310.

Fig. 313 represents wood polishing points, which are screwed into a mandrel for use with the dental engine. These points are also serviceable for removing discoloration from the teeth, such as results from depositions of calculus.

FIG. 311.

Dr. George H. Cushing's Changeable Angle Disk Carrier, Fig. 314, is easily attached and removed from the dental engine hand-piece, its angular range being indicated by the dotted lines.

A fountain mouth protector (Fig. 315), while protecting the tongue and cheek from injury, serves also to keep the disk wet. A supply of water is stored in the rubber bulb of reservoir B, by compressing and immersing it in water, and is fed as required through the small

n in the cuts by a touch of the finger on the bulb. The rung over the hand-piece, and may be turned for use in the mouth.

FIG. 312.

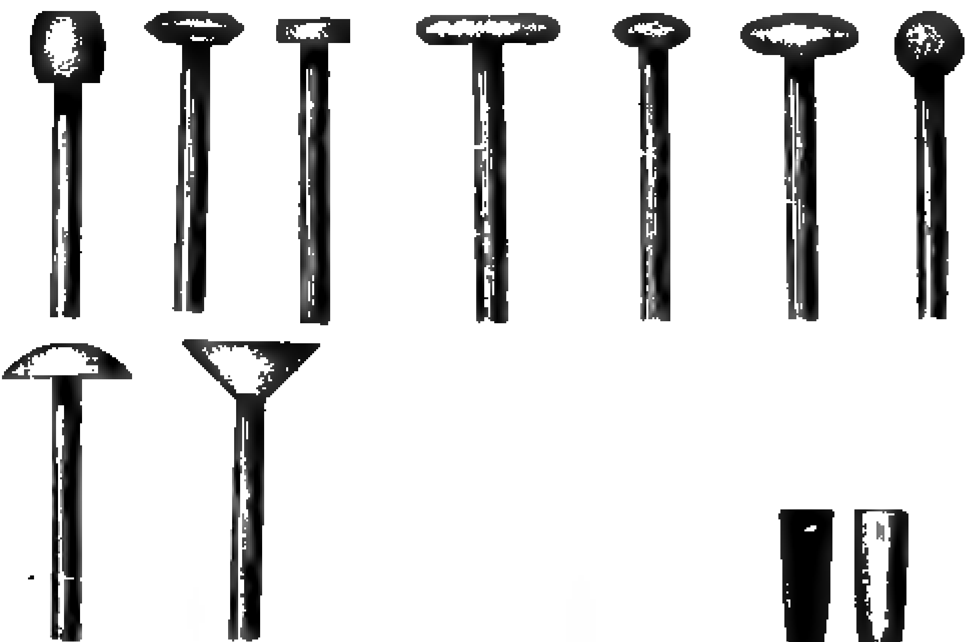
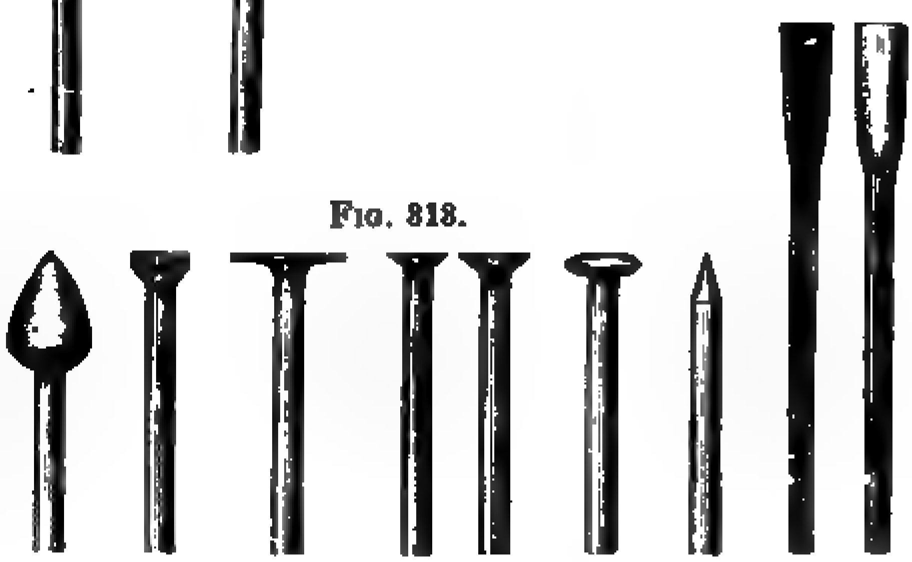


FIG. 313.



represents Dr. F. Herrick's fountain drip-point, intended up a continuous dripping of water upon corundum points, s, and other rapidly revolving instruments.

FIG. 314.

moving superficial caries all edges and sharp corners ounded and made smooth, and when the operation is he patient should be directed to keep the excised surfaces ly clean, for if the secretions of the mouth permitted to adhere to such surfaces a re- ll take place. Prior to removing superficial

caries from the approximal surfaces, and especially of the front teeth, such teeth may be separated by pressure made with wood, cotton, tape, or rubber, so that unnecessary cutting of enamel may be avoided, and but little more of the tooth-structure be removed than the decalcified part. When a portion of the approximal surface of a tooth is cut away, the excised surface should be left free and exposed to the friction of the tongue and lips, which will prevent food and other extraneous matters, as well as the secretions of the mouth, from lodging and remaining in contact with it. The portion cut away should be as much as is possible from the posterior part of the approximal surface, especially in the case of the front teeth, so

Fig. 315.

Fig. 316.

as to prevent any noticeable disfigurement. When superficial caries is located on the approximal surfaces of the bicuspids and molars, and near to the grinding surfaces, it may be removed by cutting out a V shaped space between such teeth. When enamel chisels are employed for removing superficial caries, the instrument should be grasped near its cutting edge, which should be applied in the line of the enamel fibres, using the adjoining tooth as a fulcrum for the thumb, in order to prevent the instrument from slipping and wounding the soft part adjacent. Having in such a manner removed the overhanging enamel, the softened or decalcified dentine should be cut away with a scoop-shaped excavator, the use of which will also determine the depth to which the caries has penetrated, and if not too extensive, the enamel chisel can again be employed until the surface is made level or uniform. All edges and sharp corners should be rounded and made smooth, and it may be necessary, in order to complete the cutting process, to use a curved fine-cut file. Corundum disks operated with the dental engine may be found more

convenient for the removal of superficial caries, and especially in the case of the bicuspids and molars, to be followed by strips of emery cloth or paper of the fine grades; also disks of fine sand-paper. When a perfectly smooth and normal surface is obtained, it should be highly polished with pulverized pumice or silex applied on linen tape, or on disks of flexible rubber, boxwood, or celluloid, completing the operation with polishing putty (peroxide of tin). The corundum and Arkansas or Hindostan stone points, followed by the use of wood points for the application of the polishing putty, will be found useful for removing superficial caries from exposed surfaces. When the operation of removing superficial caries is completed, the patient should be directed to keep the excised surface of tooth-structure perfectly clean. Caries upon the approximal surfaces of the teeth may be prevented by occasionally polishing such surfaces and passing floss silk between the teeth in connection with the use of the tooth-brush.

Since the introduction of the dental engine the removal of superficial caries and the preparation of the excised surface can be very effectively performed; and it should be remembered that such a surface should be left self-cleansing, so that deleterious substances may not lodge and remain in contact with it.

For separating the teeth to obtain space for the free use of the instruments employed in preparing and filling cavities on the approximal surfaces, the reader is referred to the "Treatment of Deep-seated Caries."

Separation of the Teeth.—Before a cavity can be prepared in the approximal surface of a tooth, it is usually necessary to separate it from the adjoining one. This may be done either with a file, enamel chisel, corundum disk, or by the pressure of some interposed elastic substance, or by wedges of wood driven between the teeth, or by metallic wedges or separators. Each of these methods has its advantages. When caries has extended over nearly the whole approximal surface, so that after the removal of the diseased part the orifice of the cavity will be surrounded by a thin, brittle, and irregular wall, the former is the preferable method, especially in individuals having a decided scorbutic tendency, or who have suffered from the use of mercurial medicines or syphilitic disease, and in aged persons. But when the caries has spread over only a small portion of the surface of the tooth, and is surrounded by sound, healthy enamel, the latter method should be adopted, especially in individuals in whom there is no manifest tendency to inflammation or sponginess of the gums and in young subjects. The manner of separating teeth with cutting instruments has been already described;

it will only be necessary, therefore, in this place, to offer a few remarks on separating by pressure, which was first adopted by Dr. Eleazer Parmly.

The following are its advantages, where it can be resorted to with safety: after the removal of the pressure the teeth almost immediately come together, leaving no space to injure their beauty; what is of still greater importance, the dentine around the external surface of the filling is not exposed to the action of the secretions of the mouth, or other agents capable of exerting upon it a deleterious action. On the other hand, some are of opinion that when the teeth come together again a lodgment is afforded to corrosive agents, upon the presence of which the disease was, in the first instance, produced, and which would soon cause a recurrence of it. In replying to this objection it is only necessary to observe that the parts of teeth first attacked by caries were the points in contact with each other, where the enamel may be supposed to have sustained some injury by pressure, thus rendering them more vulnerable at these points to the action of the causes that produced the disease. By properly replacing the diseased parts with gold, the external surfaces of the fillings will be the only parts that come in contact with each other, and if of gold will not be liable to injury from the above-mentioned mechanical causes. The enamel around the fillings, if proper attention to cleanliness be observed, is not so liable to be acted on by chemical agents as the dentine which the cutting instrument would expose.

But teeth cannot always with impunity be separated by pressure; it can only be done with safety in certain cases. As a general rule, the writer is of the opinion that it ought not to be attempted after the thirtieth or fortieth year of age, though it may sometimes be done with safety at even a later period. The diseased action excited for the time in the sockets of the teeth does not so readily subside at a later age; and it has in some instances been known to result in the loosening and ultimate loss of the organs. In one case which came under the observation of the author the inflammation extended to the pulp, causing its disorganization and the consequent death of the tooth.

The pressure ought never to be too actively exerted; it should be gradual and constant. From three to five days are usually required for the separation of two teeth sufficiently for the removal of the decayed part and the introduction of a filling. After they have been separated in this way, they should be kept apart, without any increase of pressure, until the soreness in the cavities shall have subsided, before any further steps are taken in the operation. Cotton

saturated with sandarach varnish, or white gutta-percha, or zinc filling materials, may be used to retain teeth after being separated with other substances, or by the rapid method. Only two teeth should be separated in the front part of the mouth in the same jaw at the same time. As soon as the cotton or tape, or other substance used to separate teeth, has afforded the desired space it should be removed, and the space retained for one or two days by cotton saturated with sandarach varnish, or white gutta-percha, or one of the zinc filling materials pressed between them, when the teeth may be well enough to permit of being operated on.

The pressure is usually made by introducing between the crowns of two teeth a thin wedge of soft wood, a piece of India-rubber, tape, a little raw cotton or ligatures, replacing the first-named substances every day or two with thicker pieces. While some prefer India-rubber to any other substance employed for the purpose, the object may be readily attained with other substances. Cotton or tape pressed firmly between the teeth and renewed daily, also gutta-percha, will in the course of a few days separate teeth, and with less soreness than India-rubber, to the use of which many object on account of the irritation it causes. Many operators prefer gradual pressure in separating teeth, but others, on account of economy of time, consider it better for the separation to be made at once, and not prolonged through several days. It is also urged that the patient suffers less and that there is also less danger to the teeth, in rapid separation than where this process is gradual. The degree of pressure and the method by which the separation is to be accomplished should, however, be determined by the susceptibility of the parts to inflammation. The operation of rapidly separating the teeth consists in the use of two wedges of fine-grained wood, either orange or boxwood. The first wedge is forced between the necks of the teeth, care being taken not to lacerate the gum, while the second wedge, which tapers more than the first, is inserted between the points of the teeth, the wedges being driven alternately by mallet force, until sufficient space is obtained, when the second wedge is removed. Very great care should be exercised in driving the second wedge between the points of the teeth, on account of the force exerted by it. This description applies to the front teeth, as it is not advisable to attempt the separation of the molar teeth in this manner.

Fig. 317 represents a set of the Jarvis Separators, by means of which adjacent teeth can be forced apart without delay or appreciable pain to the patient. This separator consists of a piece of steel, nickel-plated, bent upon itself, having the two ends formed to fit the

outer portions of the approximal surfaces of two adjoining crowns. These jaws are forced apart by the action of the screw which passes through one and against the other. The compound forms consist of two wedges approaching or passing each other, and are applicable to the incisor teeth, the first forms being applicable to the bicuspid and molar teeth.

FIG. 317.

Figs. 318, 319, and 320 represent Dr. S. G. Perry's two-bar separators, which are operated by a wrench with a double end, one straight and the other bent at an angle, to give greater facility for turning the bars in different directions. The shape of these separators permits the teeth to which they are applied to be approached readily from either side. The arrows on the bars indicate the direction

they are to be turned to spread the separator. Figs. 321, 322, a 323 represent Dr. W. A. Woodward's separators, the blades of whi

Fig. 318.

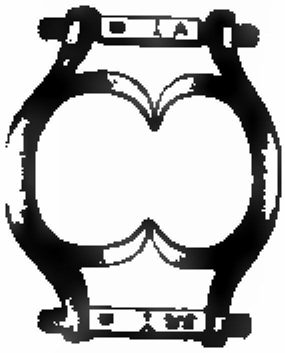


Fig. 319.

Fig. 320.

act independently, which is an advantage when the teeth a irregular.

Fig. 324 represents Chase's Dental Wedge Forceps, by whi wooden wedges can be forced between adjacent teeth for the purp of separating them, and by the use of this appliance it is claimed tl there is less danger of irritation and subsequent inflammation than the method of driving a wedge with the hand-mallet.

Fig. 321.

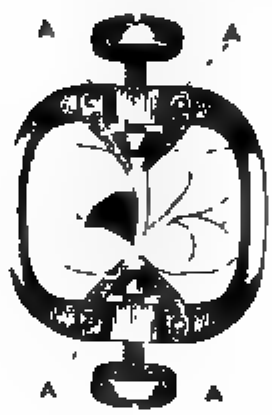
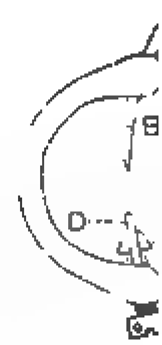


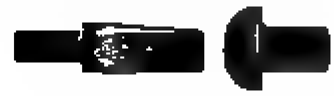
Fig. 322.

Fig. 32



Dr. Corydon Palmer recommends the following method of ra wedging: A wedge made from a thin piece of wood or quill is fi introduced between the teeth to protect the gum. Next to the fi wedge, a square, tapering one, of orange or boxwood, is introduc at the gum, in such a manner as not to interfere with the view of t wall of the cavity, and which is permitted to remain during t operation of filling, being driven to hold the space gained by a bro wedge introduced by hand pressure or mallet force between t cutting edges of the teeth, its point being directed toward the gu The separation is gradually accomplished, in order to allow the t sues to accommodate themselves to the pressure to which they a subjected. It is recommended that the rapid process for separati teeth be restricted to cases where but little space is required, a

Fig. 824.

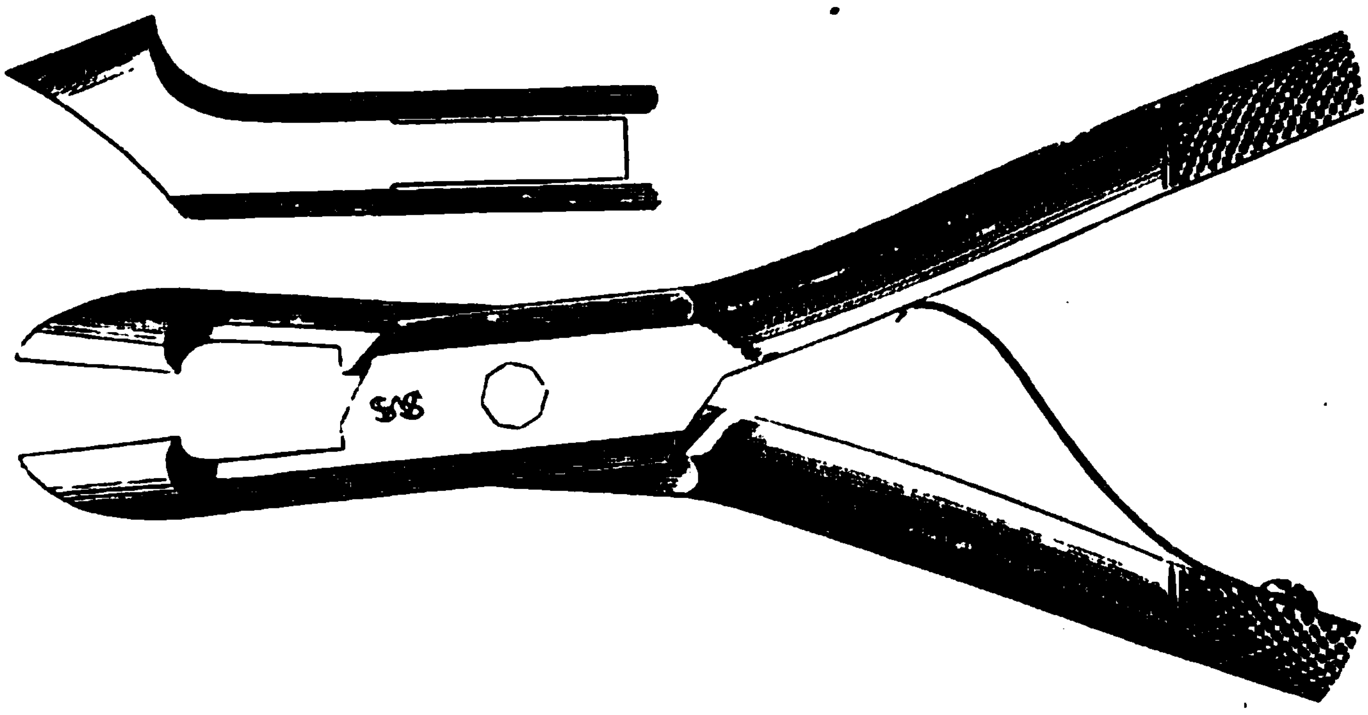


where the structures are soft and spongy. Fig. 325 represents a wedge-cutter for removing the projecting portions of the wooden wedges.

After separating teeth by rapid wedging, the wooden wedges should not be permitted to remain between the teeth, when more than one sitting is necessary to complete the operation of filling, but removed, and the space maintained by cotton saturated with sandarach varnish, or by gutta-percha, until the next sitting.

There is a difference of opinion among many prominent and skillful operators in regard to the permanent separation of the teeth, the advocates of contour fillings objecting to the removal of so much tooth-substance without substituting for it a non-destructible substance, such

FIG. 325.



as gold, while the advocates of the permanent separation method contend that self-cleansing surfaces, properly prepared, are preferable to the labor, pain, time, expense, and general strain for both patient and operator in perfecting contour work.

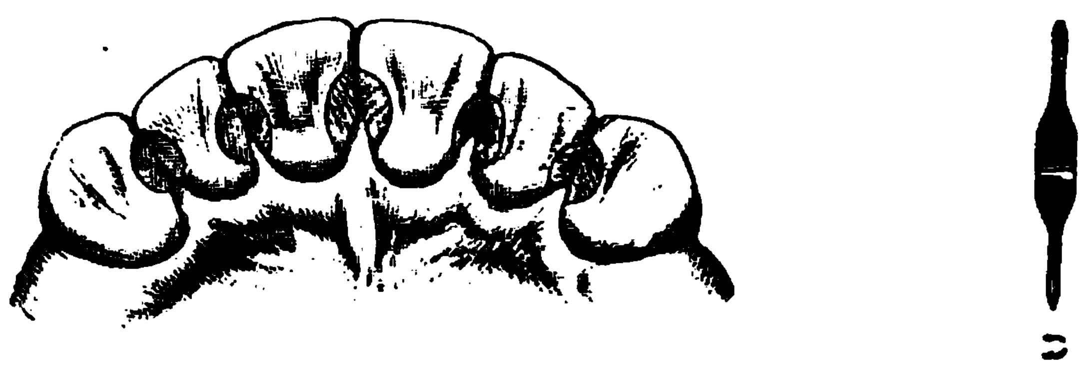
Dr. T. F. Chupein, an advocate of the permanent separation of the teeth, describes his method as follows:—

"The mode of treating the upper incisors and cuspids is indicated by the following diagram, Fig. 326.

"It will be noticed that there are semilunar spaces cut from the palatal surfaces of each tooth. These spaces are cut for the removal of incipient decay, for its anticipation, as well as to obtain room to fill when decay is deep-seated. To make these spaces without mutilating the outer faces of the teeth, we proceed as follows: Two teeth are well wedged apart by the introduction of wooden wedges, floss cotton or rubber, whichever seems best to the operator. When separated about the thirty-second of an inch or more, a thin disk is

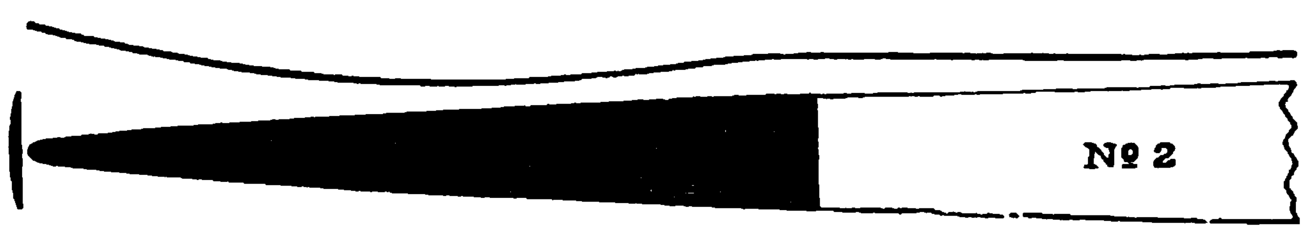
used on the dental engine. The Arthur disk, D, is about the proper size, and this is used on the palato-mesial and distal aspects of the teeth being operated on, and the cutting so shaped that the outer

FIG. 326.



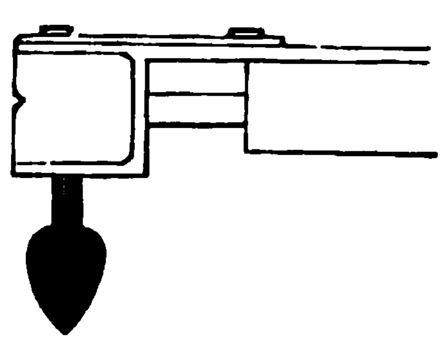
faces of the teeth are not encroached upon. After the enamel from these surfaces is removed, a curved file, like the following, may be

FIG. 327.



used to curve out the surface begun by the disk, or, what is still better, a small corundum point, mounted on the right-angle attachment of the dental engine, and applied between the two teeth to be operated on, the head of the patient being well thrown back, so that these surfaces may be readily reached. Should either of the teeth thus separated need filling, the filling should be done at once, as more room is had now than if the teeth are permitted to fall back into their old places. When two are thus separated (and filled, if they need filling), two more are wedged apart and the spaces cut, as has been described."

FIG. 328.



Concerning the treatment of the bicuspids and molars, Dr. Chupein says:—

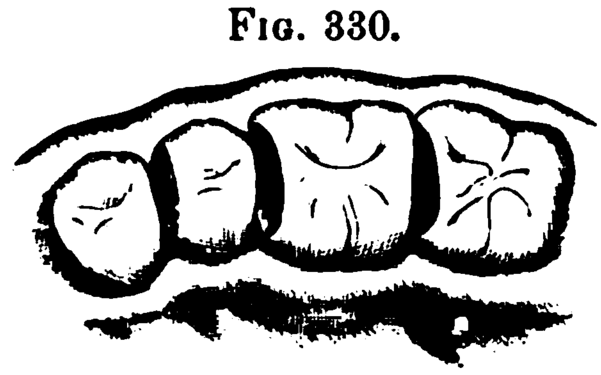
"These teeth are so concealed by the lips that even when pretty wide separations are made between them they present no revelation of their having been operated upon at all. To separate the molars and bicuspids we do not wedge them apart, as we recommend the incisors and bicuspids to be done (although it would be no detriment to do so), but we leave the teeth in the relation, one to the other, that we find them, and separate them, so as to leave a small point of contact near the gum margin. This point of contact, though

minute, is sufficient to keep the surfaces that have been deprived of the enamel by the disk or file from again approaching each other, and also serves to protect the gum from being irritated by the impaction of food. Fig. 329 will illustrate this idea.

It will be seen that the filed surfaces are entirely kept apart, and that though the tooth may change its position or turn in its socket (which is not likely) the cut surfaces would be still kept from close proximity. It also permits a free space, which is readily kept clean by simply rinsing the mouth. We fear that it is the careless manner in which this operation has been performed that has brought it into disrepute, and which, from this carelessness, has made many who tried the system abandon it as being ineffectual, when the fault lay more in the manner of its performance than in the integrity of the operation. Particular stress must be laid on the *non-removal* of this point of contact, otherwise the operation becomes ineffective. Indeed, if it is removed we consider that the operation would be worse than if nothing at all had been done. To make it entirely effective it should be done in anticipation of decay or when decay

FIG. 329.

FIG. 330.



is in its first stages—when it has not, or scarcely has, pierced the enamel. If attempted later the very point of contact we wish to preserve will be encroached on by decay or completely destroyed by it. If in anticipation of decay, the cutting need be done only from one tooth, and that from the mesial surface of the furthest back tooth. Fig. 330 will illustrate this.

We would recommend that after the teeth are separated a waxed thread be passed through the separations down to the gum, and that this should pass the point of contact *easily* and with a *snap*, to indicate that the teeth are just held apart, but yet touch sufficiently that their relation one to the other should not have been changed. The thread or silk thus used should not be frayed. This would indicate roughened edges of enamel or too close contact. If the former, it should be polished or cut smooth; if the latter, the point of contact should be lessened so that the string will pass through readily and with a snap. We recommend, too, that the rubber dam be applied on these teeth after these separations are made. It will often

appear that all decay has been removed. This deception is caused by the gloss left on the cut surfaces by the saliva, but when the dam

FIG. 381.

FIG. 382.

FIG. 383.

FIG. 384.

FIG. 385.

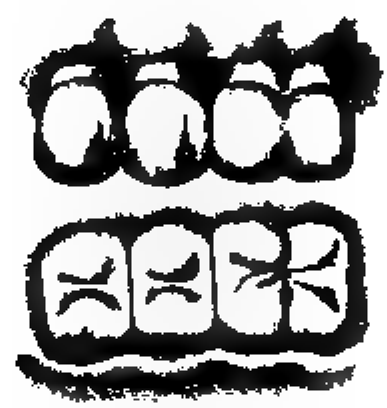
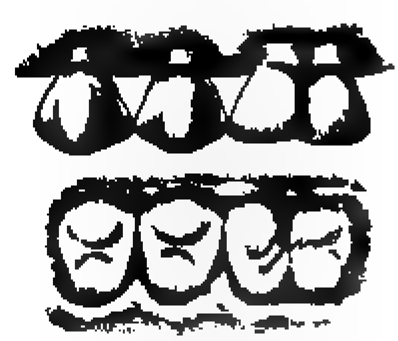


FIG. 386.



is applied and the surfaces dried and critically examined, we can know for certain if all the disorganized tissue has been removed or not.

We proceed to make these separations by arming the dental engine with a disk like that represented at Fig. 326 D. We cut the teeth through from their buccal to their palatal aspect, if in the upper, and from their buccal to their lingual aspect if in the lower jaw. We stop from time to time as we proceed, to see if we have not gone too far. When nearly down to the point of contact, near the gum, we stop with the engine and finish with a file having a round edge, like Fig. 331; or, in case of molar teeth, with a file like Fig. 332. When finished, the buccal aspects of the teeth have the appearance represented by Fig. 333, while the teeth viewed from their masticating surfaces are represented by Fig. 334.

Should it be found necessary to fill the teeth thus separated, an easy approach to the cavity is had, and the fillings as well as the filed surfaces can be left highly polished.

The class of teeth shown at Fig. 335 are such as we recommend to be treated as we have described, for they present broad surfaces of contact on their buccal, masticating, and palatal aspects, and are thus rendered more prone to decay from the ready lodgment of particles of food between them.

The other class of teeth, represented by Fig. 336, rarely decay, because, as will be seen, they touch only by minute points of contact, and are thus not liable to decay. We do not recommend teeth of this form to be separated. If they decay they should be wedged apart and filled, and allowed to fall back in their old position. Decay in teeth of this class will generally be found above the point of contact, toward the gum. Should permanent separation be attempted with teeth of this class it might prove ruinous, or if effective the teeth must, from their shape, be considerably mutilated and cut away, to prevent the cut surfaces from again falling in close apposition. Judgment, therefore, must be used in the separation of the teeth, although, as we have said, the operation is comparatively simple.

But whether the teeth be separated with cutting instruments or by pressure, the space should be sufficiently wide to enable the dentist to operate with ease, otherwise it will be impossible to remove the caries and fill the teeth in a proper manner.

TREATMENT OF DEEP-SEATED CARIES.

Filling teeth is one of the most difficult operations the dentist is called upon to perform; it often baffles the skill of operators who have been in practice many years. It is advisable only under certain circumstances, and when the operation is performed without due regard to these it may be productive of injury rather than

benefit. It is the only certain remedy that can be applied for arresting the progress of deep-seated caries; but to be effective it must be executed in the most thorough and perfect manner. The preservation of a tooth may be regarded as comparatively certain when well filled, and with a suitable material, if it be afterward kept constantly clean. At any rate, it is not likely ever again to be attacked by caries in the same place.

On this highly important operation Dr. E. Parmly thus remarks: "If preservation is as good as a cure, this is as good as both; for the operation of filling, when thoroughly performed, is both preservation and cure. And yet it must never be forgotten that this assertion is true only in those instances in which the operation is well and properly done; and perhaps it is imperfectly and improperly performed more frequently than any other operation on the teeth.

"There are reasons for this fact, into which every ambitious and honorable practitioner will carefully inquire. Although the books are explicit on this point, I deem it sufficiently important to deserve a few additional remarks. The following considerations are essential, and, therefore, indispensable to success in this department of practice. *Firstly.* The instruments used must be of the proper construction and variety. *Secondly.* The material employed must be properly prepared as well as properly introduced. *Thirdly.* The cavity which receives the filling must be so shaped as to retain it in such a manner as to exclude not only solids, but all fluids, and even the atmosphere itself. *Fourthly.* The surface of the filling must be left in such condition as to place it beyond the reach of injury from food and other mechanical agents with which it necessarily comes in contact. *Fifthly.* The tooth thus filled should be free from pain and every known cause of internal inflammation."

It is important that the operation be performed before the disease has reached the pulp-cavity; after this, the permanent preservation of the tooth may be regarded as more or less questionable. Still, under favorable circumstances, the author believes it may, in the majority of cases, be performed with success. But, as the propriety and manner of filling a tooth after the pulp has become exposed will hereafter come up for special consideration, as well, also, as the operation of filling the pulp-cavity after the destruction of the pulp, it will not be necessary to enlarge upon these subjects at this time.

MATERIALS EMPLOYED FOR FILLING TEETH.—Among the articles which have been employed for filling teeth are gold, platina, silver, tin, lead; fusible alloys of tin, lead, bismuth, and cadmium; amal-

gams, gutta-percha, oxychloride of zinc, oxyphosphate of zinc, and various preparations of the gum resins. Of these no single one can be said to unite all the requirements of a perfect material for filling, which may be enumerated: 1. Resistance to the mechanical action of mastication. 2. Resistance to the chemical action of the mouth. 3. Facility of introduction and consolidation. 4. Harmony of color. 5. Absence of all galvanic, chemical, or vital action upon the teeth or the general system. 6. Absence of all heat-conducting property. 7. Absence of shrinkage.

Gold Foil.—To the use of this material, when properly prepared, there is the least possible objection, perfectly answering the first, second, fifth and seventh requirements, to a great extent the third, if in skillful hands, but deficient in the fourth and sixth. No better material is wanted for the operation. A tooth may be so filled with it as to secure, in almost every case, its permanent preservation. It should, however, be perfectly pure, be beaten into thin leaves, and well annealed by the manufacturer before it is used. When prepared in this manner, it may be pressed into all the inequalities of the cavity, and rendered so firm and solid as to be impermeable to the fluids of the mouth.

Although there may be no difference in the purity of the gold and the thickness of the leaves, yet a marked difference will be found to exist in the malleability and toughness of the foil of different beaters.

The art of preparing gold for filling teeth is an exceedingly nice and difficult one, and is believed to have attained greater perfection in the United States than in any other country; at least, this fact is so generally admitted that many of the most eminent European practitioners procure nearly all they use from America. (See process of manufacture in Harris' Med. and Dent. Dictionary.)

The principal preparations of gold used for filling teeth are the non-cohesive, the cohesive, and the sponge or crystal gold.

Non-cohesive or Soft Gold Foil.—This is a preparation of leaf gold which does not possess the property of cohesion to such a degree that the leaves can be firmly united on being pressed together with moderate force, and is introduced on the wedging principle, the cavity for its reception being made of such a form or shape as will retain the mass after it has been properly introduced and consolidated.

Non-cohesive gold foil is employed in different forms, such as the rope, the tape or ribbon, the cylinder, the pellet, and the mat or block.

The thickness of the leaves is determined by the number of grains

each contains, and is designated by numbers on the books between the leaves of which they are placed after having been properly annealed. These numbers range from 3 to 240. A book containing a quarter of an ounce of No. 4 will have thirty leaves in it. Some dentists use foil varying in numbers from 4 up to 20, and even, of late, to 120, while others confine themselves to a single number. If but one number of the non-cohesive be used, 5 will perhaps be found better than any other. The author has used Nos. 4, 5, 6, 8, 10, and 15, but he prefers 4 and 5, and is decidedly of opinion that, in a large majority of cases, a better filling can be made with the first two numbers than any of the others. There may be cases in which higher numbers can be more advantageously employed; as, for instance, in cavities which are *very* large, and where the operation of filling has extended beyond the walls of the cavity, owing to the difficulty of securing a perfect adaptation.

Cohesive Gold Foil.—This is a preparation of leaf gold which possesses the property of cohesion to such a degree that the leaves readily and firmly unite on being pressed together with moderate force.

Although one or two others claim priority in the discovery of the advantages now derived from the use of cohesive gold foil, yet the credit is certainly due to Dr. Robert Arthur, as he was not only the first to demonstrate the applicability of this form of gold in filling teeth, but in a series of well-written articles* he overcame the objections which were at first urged against it, and proved that its great cohesive property rendered it a valuable adjunct in the preservation of the teeth. This form of foil is so cohesive that any number of pieces may be welded one to another; thus a part, or even the whole of the crown of a tooth may be built up with it. The same property may to a limited extent also be imparted to foil manufactured in the ordinary way by reannealing. This property is peculiarly valuable in many cases where it becomes necessary to build up a large portion of the crown of a tooth; but when it is used, instruments having serrated points are required, like those employed in the use of crystal or sponge gold.

Crystal or Sponge Gold has been employed by dentists for filling teeth for a number of years. The author has used it in a number of cases with very satisfactory results. Since the publication of the fifth edition of this work, the properties of crystal or sponge gold have been more thoroughly and extensively tested, and the result

* A Treatise on the Use of Adhesive Gold Foil, 1857.

has fully confirmed the favorable opinion entertained by us with regard to its value. The author is acquainted with several of the most skillful operators in the United States who have used it almost exclusively in their practice for several years, and has seen fillings made by some of these gentlemen which, for beauty and solidity, he does not think could be surpassed. This form of gold has a spongy texture, being composed of crystals, and widely differs from foil or leaf gold. The crystals possess the property, when pressed firmly against each other, of welding and becoming as solid and almost as incapable of disintegration or crumbling as a piece of bullion or coin. This property enables a skillful manipulator to supply almost any loss which a tooth may have sustained, even to the building up of an entire crown. Still, it will never supersede the use of cohesive and non-cohesive gold foils, as there are many cases in which leaf gold can be used more advantageously and with more facility. Nor will the employment of it, in the opinion of the author, ever become universal, for the reason that more care and skill are required to make a good filling with it than with leaf gold, especially when the cavity in the tooth is difficult of access. Filling with crystal gold is more tedious than the same operation with ordinary foil.

Experiments have been made with *silver*, *platinum*, and *aluminium*, but with unsatisfactory results. They are less malleable than gold, and therefore cannot be made so thin; at the same time they have not the softness of tin, hence they work harshly under the plugger. An additional objection to silver is its liability to undergo chemical change, being in this respect greatly inferior to pure tin. Platinum, while it possesses indestructibility, in this respect being even superior to gold, is deficient in other properties as a filling material, as it cannot be welded with facility, is difficult to manipulate in the form of foil on account of its stiffness and harshness, and hence cannot be adapted and condensed in such form to the surface of a cavity. A form of platinum known as *platinum sponge* has been employed with greater facility than platinum in leaf form, but it requires skillful manipulation, and its cohesive property is readily destroyed by the slightest degree of moisture. Platinum has also been used in the form of foil coated with a considerable thickness of pure gold, and it is claimed that by such a combination a denser filling can be made, and also one conforming to the color of the tooth in which it is placed. The peculiarity of aluminium, in this relation, is the impossibility of welding its leaves by pressure; even under the gold-beater's hammer it forms loose scales, which no annealing can make adherent.

Tin Foil.—This, when chemically pure and properly prepared, is less objectionable for filling teeth than most of the articles hereafter enumerated. Under favorable circumstances, if skillfully introduced, it will prevent the recurrence of caries. The greatest objection, perhaps, to the use of tin foil as a filling material is its softness and consequent inability to withstand the friction of mastication for many years. When used in cavities not so exposed it answers a good purpose as a filling material, as it is unalterable by reagents. Being an inferior conductor of heat it is tolerated in sensitive teeth in cases where a better conductor, such as gold, would not be. It is also regarded as valuable in soft teeth, and some regard it as possessing advantages over gold for filling in such teeth, and also in the temporary teeth, being easy of introduction and in accord with the tooth-structure. On account of the qualities referred to, tin foil is sometimes employed for lining cavities to be filled with gold. It is prepared as a filling material in the form of foil, the leaves varying in thickness from No. 4 to No. 20. The numbers from 4 to 10 are mostly used, and it is manipulated in the same manner as non-cohesive gold foil.

Lead is far more objectionable than tin, as it is more easily decomposed by the secretions of the mouth; its introduction into the stomach might be productive of serious injury to the general health of the patient. But, happily, this article is now seldom, if ever, used.

Amalgam, formerly known by the name of *mineral cement,* or *lithodeon,* is usually composed of about equal parts, by weight, of pure tin, silver, and varying proportions of zinc and platinum—and sometimes gold and copper—the zinc, about one to three per cent., constituting a most important element in controlling shrinkage and preventing oxidation. The gold is not especially valuable, and when used in an amalgam from one to four per cent. is sufficient. These metals are melted in a crucible and poured into ingots, which are then cut up with a file into filings. These filings are mixed, after the cavity in the tooth is prepared for the filling, with about thirty-three and one-third per cent. of distilled mercury, and incorporated to the consistency of a thick paste. The mass is then thoroughly washed with alcohol, to which is added a few drops of a strong solution of chloride of zinc. The excess of mercury is then removed by twisting the mass in a piece of chamois skin or strong muslin. It is also recommended to press the mass quite thin, after it is removed from the chamois skin, with a strong pair of flat pliers, in order to remove still more of the mercury. Caution should, however, be used to avoid pressing out too much mercury. The mass, when

introduced, should be about the consistency of ordinary putty The cavity should be prepared with as much care as for a gold filling, and moisture prevented from coming in contact with it. When the cavity approaches near to the pulp, some non-conducting substance, as Hill's Stopping, should be applied between the amalgam and the bottom of the cavity. After the filling has become sufficiently hard, its surface should be carefully finished by filing and burnishing.

Dr. Bonwill gives the following directions for working amalgam composed of silver, tin, and gold; from 5 to 7 per cent. of the latter he considers sufficient, condemning the use of zinc:—

"As soon as the first piece of alloy is inserted, a wad of bibulous paper (Japanese) as large as the cavity is placed thereon, and an oval-pointed steel instrument is pressed upon it with great force, to crowd out the superabundant mercury. Go on adding alloy and more paper until the cavities are crowded full from cuspid to molar, leaving no intervening space. Direct pressure is not as efficacious as rubbing the amalgam in with a burnisher over the paper, which drives the mercury out at all points. No rough-faced instrument should be used; smooth burnishers and oval-faced only, on the same principle as in rubbing in gold by the action of the mechanical mallet. When you have reached nearly the proper fullness, use the flatter burnishers entirely, to not only add the alloy, but to be sure that the mercury is carried to the edges. To do this you must not lose a moment; and the alloy should not have too much gold in it, or you cannot undertake so much at one sitting."

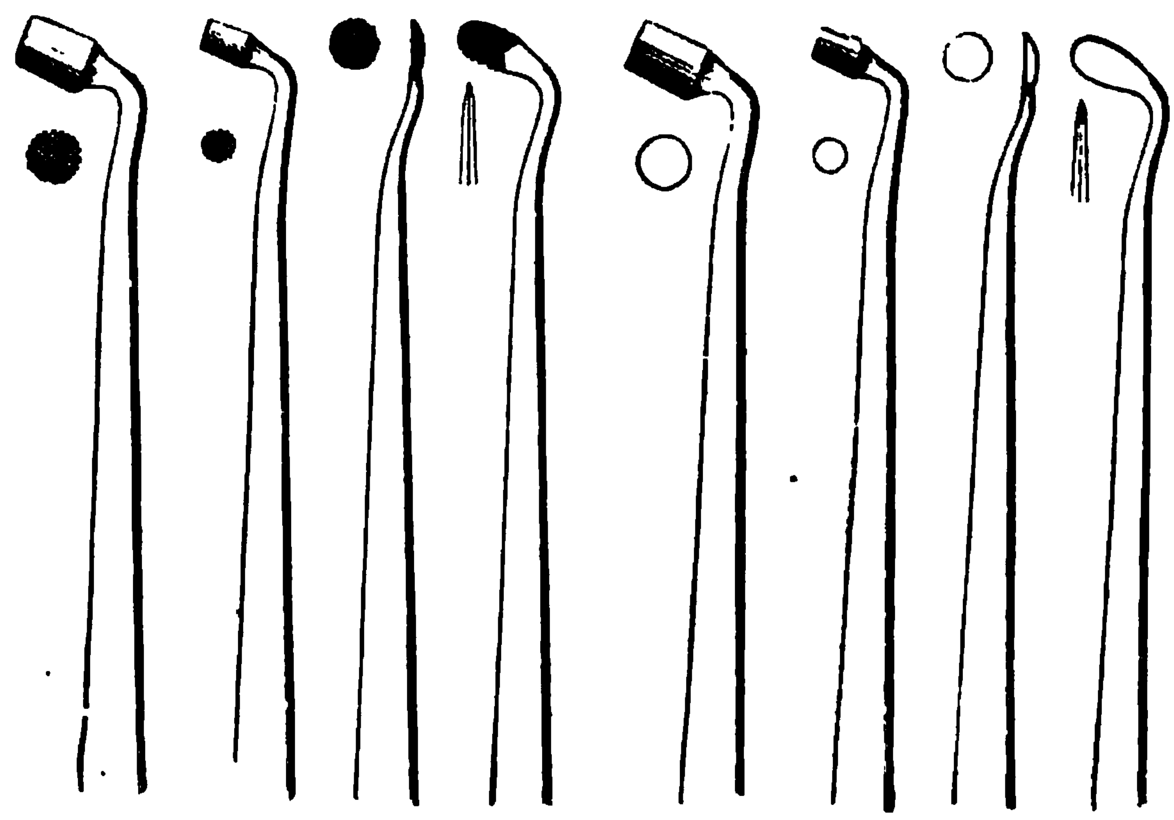
Describing the operation of filling with amalgam the superior cuspid decayed on its distal surface, with the first and second bicuspids on the anterior distal, and grinding surfaces gone so far as to leave nothing standing but the buccal and palatal walls, and to this add the first molar with its anterior wall, crown, and distal surfaces as seriously involved, the same writer continues:—

"By the time you have gotten all the cavities full, you must commence at once to divide between each and contour.

"It will be found that when the opposite teeth are made to antagonize with it, great care must be used to keep from dislodging any portion of this large mass; therefore, before the division on the approximal surfaces is made, see that the articulation is absolutely correct. Then with a broach with small point turned, scratch away all the cervix until the tool reaches from both buccal and palatal surfaces, and the divisions are clear to nearly the grinding surface. Now, with a very thin knife or saw you can carefully divide the fillings, to make each tooth distinct. In this proceeding great care must be exerted

or the contour will be broken. When this has been done, shape with proper instruments, leaving all the grinding surface in contact as broadly as possible, so that when the teeth go back again to their positions from which the gutta-percha had moved them, the food cannot wedge down between them. Where cavities are obscure on approximal surfaces, get the alloy as nearly in place as you can, and a wad of paper will be sure to force it down. Besides those cases with more or less walls for support, in those where much of the cusps of either wall is gone the alloy can be added and compressed easily and surely. Entire or partial crowns can be secured in a few minutes. Be sure that the alloy is not allowed to remain projecting over the free margin of the contour before the patient leaves. Then but little

FIG. 337.



dressing of the contour is necessary when the operations are filed and finished."

Fig. 337 represents a set of what are known as Arrington's amalgam instruments.

Amalgam becomes hard by the crystallization of the mass and the evaporation of the mercury; hence, without a well-prepared form is used, and great care exercised in its amalgamation and introduction, a filling of this material may either contract or become porous; and when the latter is the case the oxidation extends to the tooth-structure, which becomes, as a consequence, discolored.

Amalgams, unlike the plastic gutta-percha and zinc preparations, do not adhere to the walls of the tooth-cavity; hence, in their use it is necessary that attention should be paid to the form of cavity into which they are to be introduced; and as they are often employed for filling cavities of a shallow form, and with frail walls, under-cuts

and dovetails are required for the retention of such fillings. From the tendency of the amalgams of mercury to assume a spheroidal shape and separate from the margins of a cavity, sharp angles and pits are objectionable. The addition of palladium to an amalgam may prevent such shrinkage, but adds to the discoloration, and the rapidity of its setting is such as to evolve a sufficient amount of gas to cause an explosion with emission of light. Such an accident may be avoided by gradually adding the palladium powder to the compound and using very small pieces for introduction, and their rapid insertion, each piece being well compounded as it is added to the mass. It is claimed that while the surface of a palladium amalgam changes to a black color, it does not stain the tooth structure, and that it is the most durable of the amalgams. An excess of silver will also cause an amalgam to blacken and stain the tooth-structure. Silver and copper control the change in form, as the solid particles of copper which remain have an amalgamated surface only, which prevents the change in form common to a homogeneous mass. Platinum imparts toughness and edge-strength to an amalgam. Gold makes an amalgam composed of tin, silver, and mercury unclean, although an amalgam of pure gold and mercury alone is white and clean, but is not adapted for a filling material.

A better class of amalgams has been recently introduced, which appears to change bulk to a less degree and to preserve their light, silvery color much better than the older forms; hence, the former objections to this filling material appear to have, in a great measure, been overcome. The ease with which amalgam fillings can be introduced no doubt often leads to carelessness in the manipulation of this material, but it should be remembered that to obtain the best results from it the cavity in which it is placed should be as carefully prepared as for a gold filling, and also that perfect dryness is essential to its adaptation and durability.

There exist some differences of opinion concerning the necessity for washing amalgam, prior to its introduction, with alcohol and other fluids, some contending that by so doing it is impossible to remove all of the moisture in time for its insertion. Sufficient mercury should be allowed to remain in the mass as will permit of its being manipulated without crumbling, and when it is inserted over a sensitive surface or in proximity to the pulp of a tooth, some intervening substance, such as Hill's Stopping or oxyphosphate of zinc, should be placed between the sensitive surface and the filling.

It is claimed that continuous pressure with the burnisher upon the surface of an amalgam filling during its setting will prevent its

tendency to separate from the walls of the cavity, and insure better results from its use. It is also very necessary that the margins of amalgam fillings should be well defined, as, owing to its brittle nature, thin, overhanging portions are liable to break away, leaving imperfections which may soon prove injurious to the filling. After an amalgam filling has become hard (and during this hardening process the patient should be warned against masticating upon it) the surface should be as carefully prepared and polished as that of a gold filling.

The objections, therefore, urged against amalgam are, that it oxidizes and blackens; that the tooth-structure with which it remains in contact becomes discolored; that it contracts in hardening, allowing the secretions to make their way around the filling. Of late years it has been urged that it is incompatible with tooth-structure, and that the mercury might act injuriously on the system. These objections are characteristic of most of the amalgams now on the market, although in a few notable exceptions they have been almost entirely overcome; but there is no good reason why amalgam should be incompatible with tooth-structure, or that the small amount of mercury imprisoned in this alloyed mass should possibly produce any mercurial effects. There is good reason, therefore, for believing it to be, in these respects, perfectly inert. The use of amalgam is *contraindicated* in all teeth which can be filled with gold—in the front teeth on account of its color, and in pulp-cavities on account of the difficulty of introduction into small canals. Various opinions are held as to the indications for the use of amalgam. In our own opinion it is one of the most valuable materials for some operations, as, for instance, in cavities so difficult of access as to render the introduction of a perfect gold filling doubtful, and where the operation would be long, tedious, and difficult to both patient and operator, were gold used.

Fig. 338 represents a number of amalgam Carriers and Fillers.

Of these instruments, Nos. 1, 2, and 3 are constructed with fixed points, covered by a tube, which projects to form a cup for the amalgam, and recedes so that the points work through as Pluggers to force it into the cavity, No. 1 being half curve, No. 2 double-end, giving two angles, and No. 3 straight. No. 4 has a fixed tube with spring plunger to force in the amalgam. The Loadstone Carrier and Plugger, No. 5, is a double-end instrument, one point of which is so prepared as to attract amalgam, which will adhere to it while being conveyed to the cavity in the tooth; the reverse end is made as a Filler.

FIG. 338.

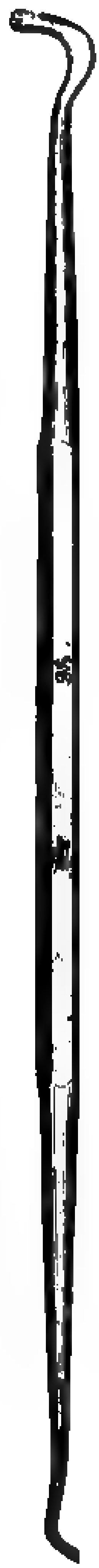


FIG. 339.

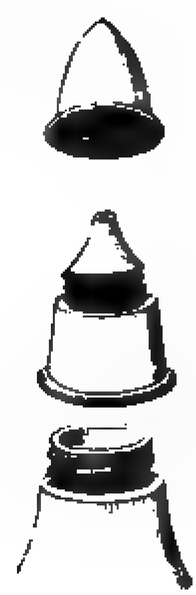


Fig. 339 represents a Mercury Holder for convenient preparation of amalgam.

Fig. 340 represents a set of Weston's Amalgam Pluggers.

Robinson's Textile Metallic Filling has been in use for several years, and, on account of its containing no mercury, has, with some practitioners, taken the place of amalgam in a large per cent. of cases. It is not advisable to introduce it in very large pieces, as they cannot be manipulated with accuracy, and a filling of this material should be commenced with a cylinder or mass, and the remaining portion packed in the form of strips. It is necessary that it should be thoroughly malleted throughout the whole process of filling, as otherwise it may disintegrate under mastication. When it is combined with gold, and both metals are exposed to the fluids of the mouth, the textile filling will become black, which, however, is said to occur on the exposed surface only, and not inside the tooth.

Gutta-percha and Hill's Stopping.—Gutta-percha is an excellent material for temporary fillings. It may be made harder, whiter and less contractile by incorporating with it some very fine powder of feldspar, silex, lime, or magnesia. A very excellent preparation known as *Hill's Stopping* is made by mixing gutta-percha with as much of the following powder as it will hold without becoming brittle; quicklime, two parts, very fine quartz and feldspar, one part each. Of all temporary fillings this is probably the best yet known. Prepared gutta-percha and Hill's Stopping are introduced in small pieces by first warming on a porcelain or metal-slab, over an alcohol lamp, until they become plastic enough to be readily pressed into the cavity and to adhere to its walls. As soon as the cavity is filled, an instrument having a condensing point large enough to cover the entire surface of the filling should be applied and kept in position until the mass has become cool.

Fig. 341 represents a cup for heating gutta-percha fillings, devised by Dr. Flagg. It is made of brass, silver- or nickel-plated, to be filled with water and warmed over a spirit-lamp. The pellets are placed upon the top of the heated cover, from which they are taken up when introducing them into the cavity. The surface of the filling is then cut down and burnished, after which a little chloroform may be applied by means of a camel's-hair brush to complete the finishing process.

The preparations of gutta-percha now used for filling materials possess different grades of plasticity, so that a filling may be commenced with one that softens at a low temperature, and finished with

another which requires more heat to render it plastic, and hence becomes harder. For cavities situated on the approximal surfaces

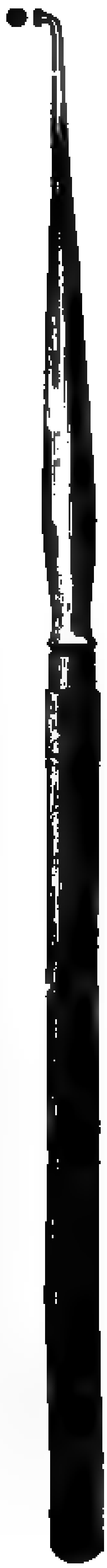


Fig. 340.

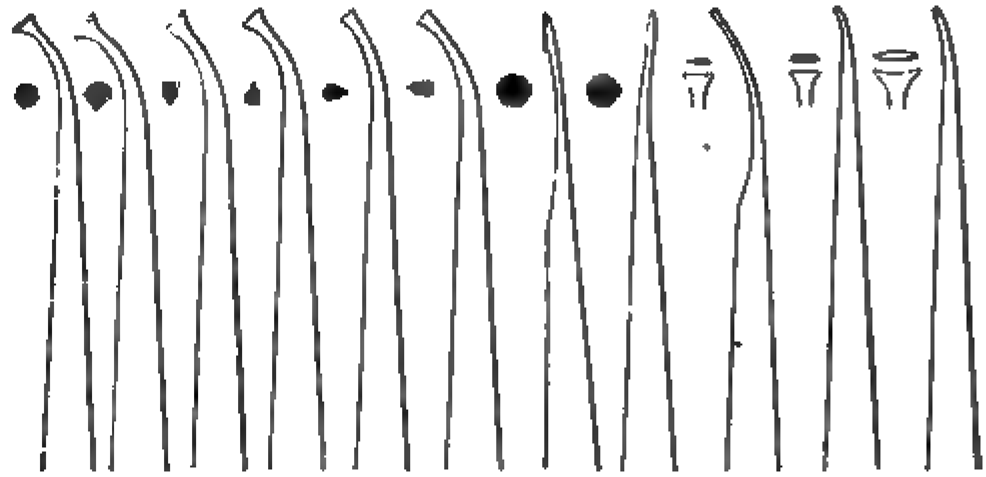


Fig. 341.

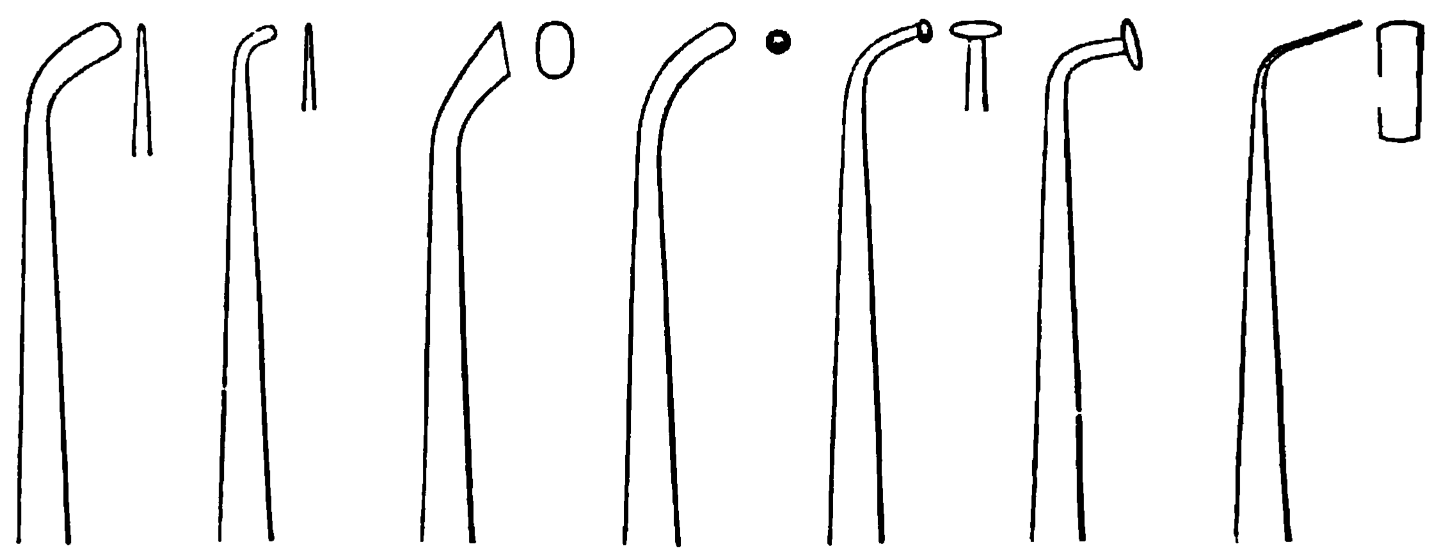
of the teeth and extending below the margin of the gum, gutta-percha preparations appear to answer a good purpose in resisting

the dissolving action of the acid from the inflamed gum. When the gutta-percha preparation is made plastic enough to adhere to the walls of a cavity, by passing it through the flame of a spirit-lamp, care is required that it should be evenly heated and not burnt. By using the lower grade over sensitive portions of a cavity less pain is experienced from the heat, and after the cavity is filled with the higher-grade material the surplus can be removed with thin steel or platinum spatulas heated to the required degree, and the surface made smooth by passing over it a burnisher. Chloroform applied to the surface of a gutta-percha filling will give a smooth finish, but may render such a surface less durable on account of its dissolving action.

Fig. 342 represents a set of Dr. W. A. Bronson's gutta-percha instruments.

Zinc Preparations.—A mixture of chloride of zinc and oxide of zinc has been much used under the various names of *oxychloride of*

FIG. 342.



zinc, os-artificial, osteo-dentine, osteo-plastic, mineral paste, etc. Quackery has seized it with eagerness, and plastered up many teeth with a mortar even more conveniently used than amalgam. Although in some few cases it may resist the action of the secretions of the mouth, it will not answer for a permanent filling. The friction of mastication soon destroys it, and in approximal cavities it frequently crumbles away in a few weeks or months. Still, as a *temporary* filling, it may, if employed with caution and judgment, be found useful, and for certain cases very valuable. It has been used with success for filling the pulp-cavities of the teeth. It has also been applied to exposed nerves, and in some favorable cases successfully, but its use for such a purpose is very uncertain, as the escharotic action of the zinc chloride will almost certainly produce death of the pulp. In the combination of the oxychloride ingredients the oxide

of zinc is usually mixed with some siliceous substance, to increase the hardness, and the chloride of zinc is diluted with water. When the powder and liquid are combined a cement results, which forms hydrated oxychloride of zinc by the taking up of some of the water as a base. Some prefer mixing the oxychloride in the form of a thin paste, and after adapting it carefully to the bottom and sides of the cavity, or over a sensitive surface, to complete the operation with a paste of thicker consistency. A warm burnisher will hasten the setting of the oxychloride and apparently increase its hardness. The application of talc (soapstone) in the form of a properly-shaped point, which may be heated, or in the form of powder, appears to improve the surface of such a filling by rendering it less permeable to moisture. On account of the oxychloride preparation being acted on by weak acid and even alkaline solutions, it cannot be depended upon for a permanent filling material, and will frequently dissolve away in a few weeks or months, especially if introduced near to or beneath the margin of the gum. It often answers a good purpose when applied to sensitive dentine, but, like the chloride of zinc, one of its ingredients, its application causes considerable pain for a short time. It has also been employed for bleaching discolored dentine, and as an interposing substance between a thin wall of cavity and darker, but more durable, filling material, such as amalgam.

Of late years various preparations, known as *oxyphosphates of zinc*, have been introduced, composed of the basic oxide of zinc and glacial phosphoric acid. One of these preparations is said to be composed of the nitrate of zinc and phosphoric acid. The oxyphosphate preparations are preferable to the oxychlorides on account of their being less irritant to the pulp and more durable, especially when placed about the necks of the teeth. They have also the advantage over the oxychlorides of greater hardness, but it should be remembered that all of the zinc preparations are liable to be dissolved by the fluids of the mouth, and hence are not so reliable for temporary fillings as gutta-percha, especially the form known as Hill's Stopping, particularly where such fillings extend beneath the margin of the gum to the cementum.

The oxyphosphates mix less readily than the oxychlorides, and require more care in the combination of the powder and liquid. If mixed too thin, a sticky, unmanageable mass results, and if too thick the mass will crumble in pieces; it is therefore recommended to so prepare it that it may be rolled between the thumb and finger without adhering to them, or, on the other hand, crumbling to pieces.

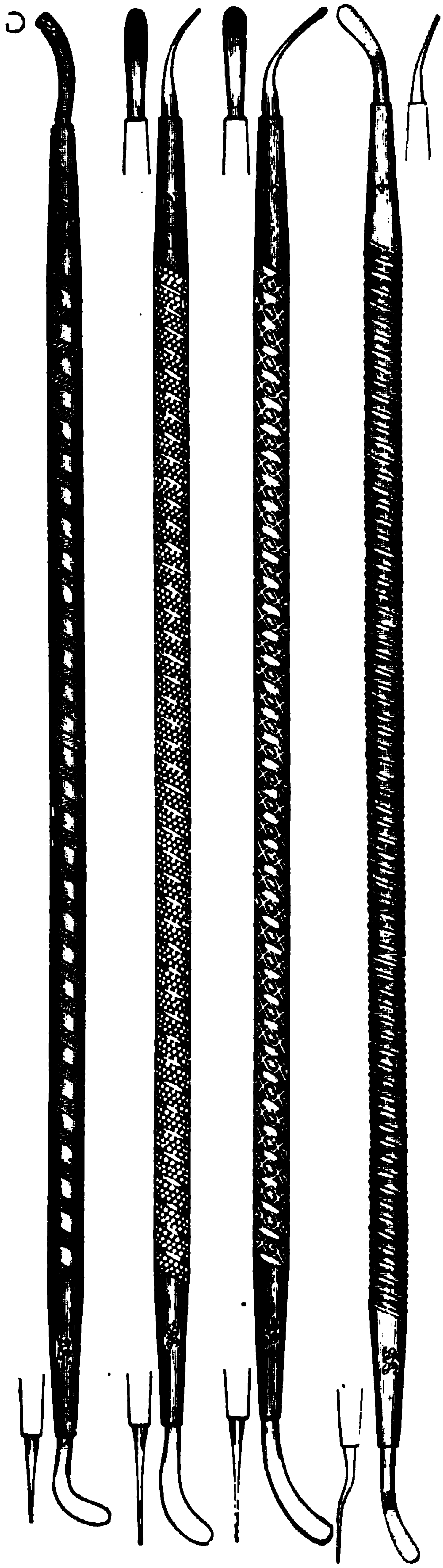


Fig. 343.

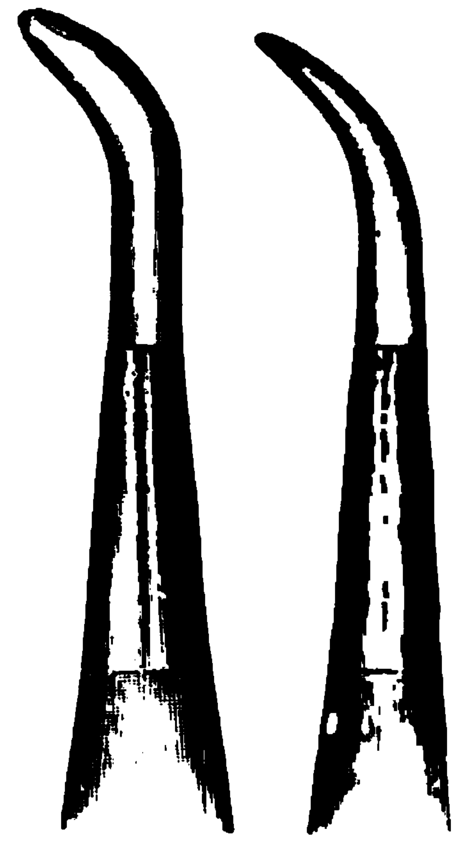


Fig. 344.

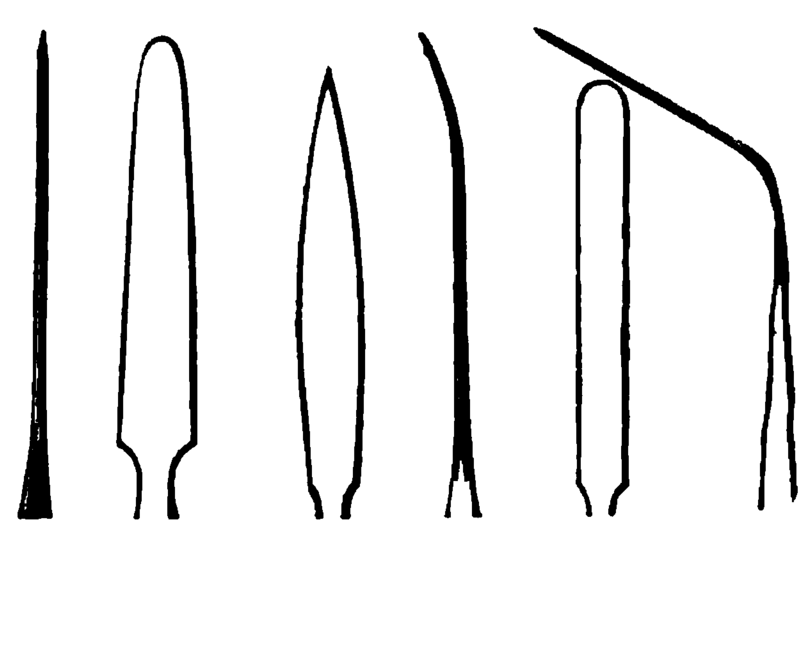


Fig. 345.

On account of the oxyphosphate setting very rapidly, the cavity should be ready to receive it before it is mixed, by being free and protected from moisture by the application of the rubber-dam. Like the oxychloride, it is necessary that the surface of a filling of this material should be protected from moisture for some minutes after its introduction, and the same substances may be used to coat over the surface, as in the case of the oxychloride. Unlike the oxychloride, however, a warm instrument cannot be employed to hasten its setting. A number of forms of these cements are in use under the names of those originating them. One form, known as Poulson's, is the pyrophosphate of zinc, the pyrophosphoric acid being in crystals, which require to be melted in a platinum or porcelain spoon held over a spirit lamp, care being taken that ebullition does not occur. When reduced by heat to the consistency of glycerine, it is dropped upon a warm porcelain slab, and is ready for introduction into the cavity. Exposure of this preparation to the air causes its deterioration, hence it should be kept in hermetically sealed vessels. Some of these plastic zinc preparations appear to be much less soluble in some mouths than in others, and considerable importance is attached to the manner in which they are mixed and inserted into the cavity.

In using any of these preparations the cavity is prepared as usual; then a small quantity of the liquid (either the chloride of zinc or the phosphoric acid) is dropped upon a piece of glass or porcelain, and enough of the powder (oxide of zinc) added to make a paste so thick that the surface will not appear watery. The cavity is then perfectly dried and protected from saliva and the material quickly introduced, after which it is kept free from moisture for ten or twenty minutes. When sufficiently hard, the surface is finished by scraping and polishing. The longer the surface is kept dry, the harder these materials become. Coating the surface with sandarach varnish (or gutta-percha dissolved in chloroform, or melted wax) will afford protection for some time.

In all cases where these preparations are introduced near a pulp, or as a capping over exposed pulps, the cavity should always be previously wiped out with a solution of gutta-percha and chloroform, to prevent the escharotic and irritant effect.

Fig. 343 represents platinum points for oxychloride and oxyphosphate filling.

Fig. 344 represents the agate burnisher, which is considered to be superior to any other burnisher for surface finishing of oxychloride and oxyphosphate fillings.

Fig. 346.

Fig. 347.

Fig. 345 represents the points of different forms of spatulas for mixing the zinc preparations, which is conveniently done on a porcelain palette, such as is used by artists.

Fig. 346 represents a common form of mouth mirror, of which both plain and magnifying are used in examining the teeth. Dr. Maynard, of Washington, has recently made an improvement in mouth mirrors, by substituting pebbles for glass, which more clearly reflect the objects they picture.

Fig. 347 represents reflectors for attachment to rubber-dam clamps, so that while providing a strong light, both hands of the operator are left free for manipulation. They are useful in operations upon posterior cavities in molars. By means of a ball-joint the mirror can be adjusted to concentrate the light upon the cavity or any portion of the mouth required.

Instruments known as stomatoscopes have been devised for the purpose of obtaining a perfect light for operations on the distal surfaces of molars and bicuspids, and are found to be especially useful when the sky is cloudy and for night work. Such instruments as the Grohnwald and Beseler stomatoscopes, which are capable of being so adjusted as to throw light to any part of the mouth necessary in filling teeth may be used. Dr. C. F. W. Bodecker asserts that by aid of a stomatoscope he was enabled to see up to near the apex of the pulp-canal of a palatal root of a first upper molar, the cavity being on the distal and grinding surface.

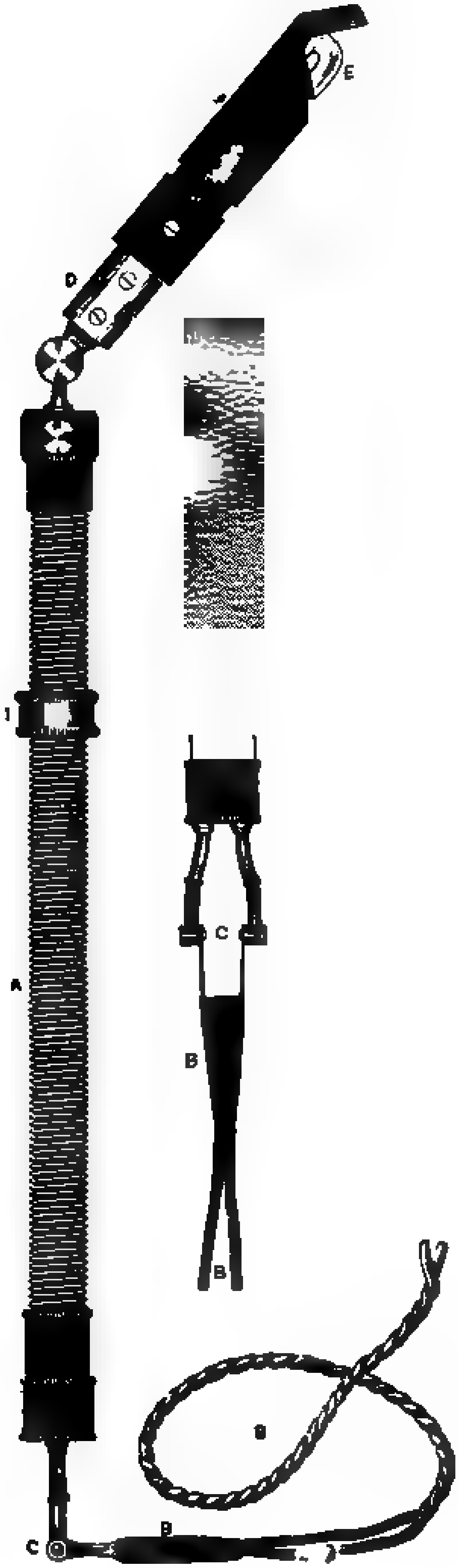
The electric light has also been utilized for the same purpose, and also for examinations of the throat, and even of the stomach. Mr. E. T. Starr, of the S. S. White dental establishment,

has recently succeeded in obtaining highly satisfactory results in this direction. His instrument consists of a lamp formed of a delicate glass bulb, from which the air has been withdrawn and as nearly a perfect vacuum created as possible. The bulb varies in shape, being spheroidal, flat, and compass-shaped, and also cylindrical, with a conical termination. Through the thin wall of the lamp run the conducting wires, connected by a carbon arc, on which the electricity centres, and which thus becomes the place of light. The glass lamp is very small, the cylindrical-shaped being scarcely half an inch in length, and with a diameter much less than that of an ordinary lead-pencil. The compass-shaped lamp is about one-quarter of an inch thick, and has a diameter of three-quarters of an inch to an inch, while the spheroidal is scarcely larger than a good-sized pea. The lamp is attached to a handle from seven to nine inches long and about half an inch thick, through which run the wires connecting with the battery. The intensity of the power and the brilliancy of the arc of light can be regulated by moving along the handle a ring which connects with the wires. The handle has several joints, and its position can be arranged so as to adapt it to the shape of the cavity it is to illuminate. Mirrors can also be fastened to the lamp, and light reflected to places where the lamp cannot be introduced. To prevent the too great radiation of heat and the diffusion of light, the lamp may be partially covered with a hard rubber or gutta-percha case. When the lamp is placed in the mouth of a patient, every portion of the throat, even to the lowest parts, and every recess of the upper places can be plainly seen. Placed behind the teeth, the intense light renders not only the teeth, but even the gums above, highly transparent. If the teeth are good and free from caries, no lines will be visible, but the presence of a filling or the beginning of caries may at once be seen. When the lamp is placed within the mouth, and the lips are closed, the entire front structure of the mouth is brought to view. No unpleasant sensations are experienced, even in cases of protracted use.

Fig. 348 represents the "Electric Mouth Lamp," or "Stomatoscope."

The electric mouth lamp will be [found an invaluable assistant to the dentist in diagnosing lesions of the teeth and associate parts, especially in those obscure cases where, although there are unmistakable symptoms of serious pathological disturbance, careful examination with the appliances heretofore in vogue fails to discover the exact location of the trouble. Sound teeth are sometimes needlessly sacrificed in fruitless endeavors to find the seat of neuralgic pains for which, owing to the insufficiency of the means of diag-

Fig. 348.

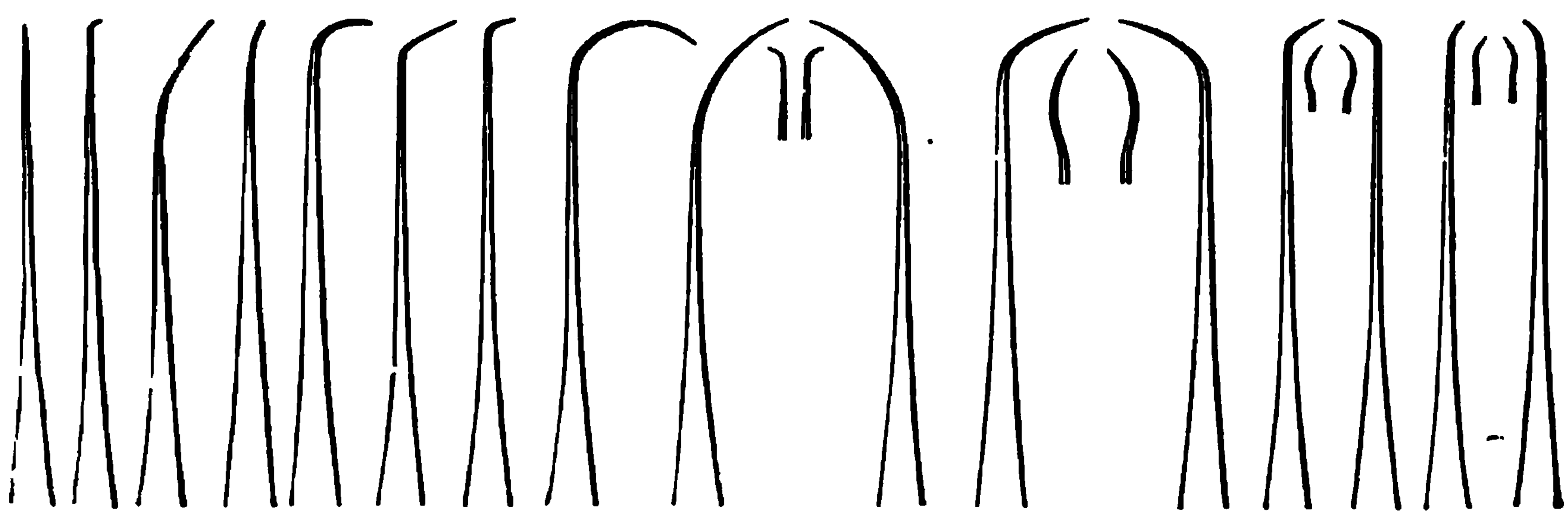


nosis, no satisfactory cause can be established. The electric mouth lamp illuminates the oral cavity so brilliantly that any departure from normality, whether it be a hidden cavity of decay, an unsuspected dead pulp, or even the slight thickening of the tissues which is the precursor of decay, is unerringly detected.

This apparatus will also be found very useful in the operating room in other directions. In the preparation of inaccessible cavities it is often difficult to tell when the excavation has proceeded far enough, but the electric mouth lamp will show at once whether all the disintegrated tooth-substance has been removed.

In use the lamp is placed behind the object to be illuminated—that is, so that the object is interposed between the lamp and the eye of the observer. Thus, in examining the teeth the lamp is placed within the arch, so that its light falls upon the lingual or palatal surfaces of the teeth, while the eye of the operator is directed to the labial or buccal surfaces. So lighted, every portion of the teeth

FIG. 349.



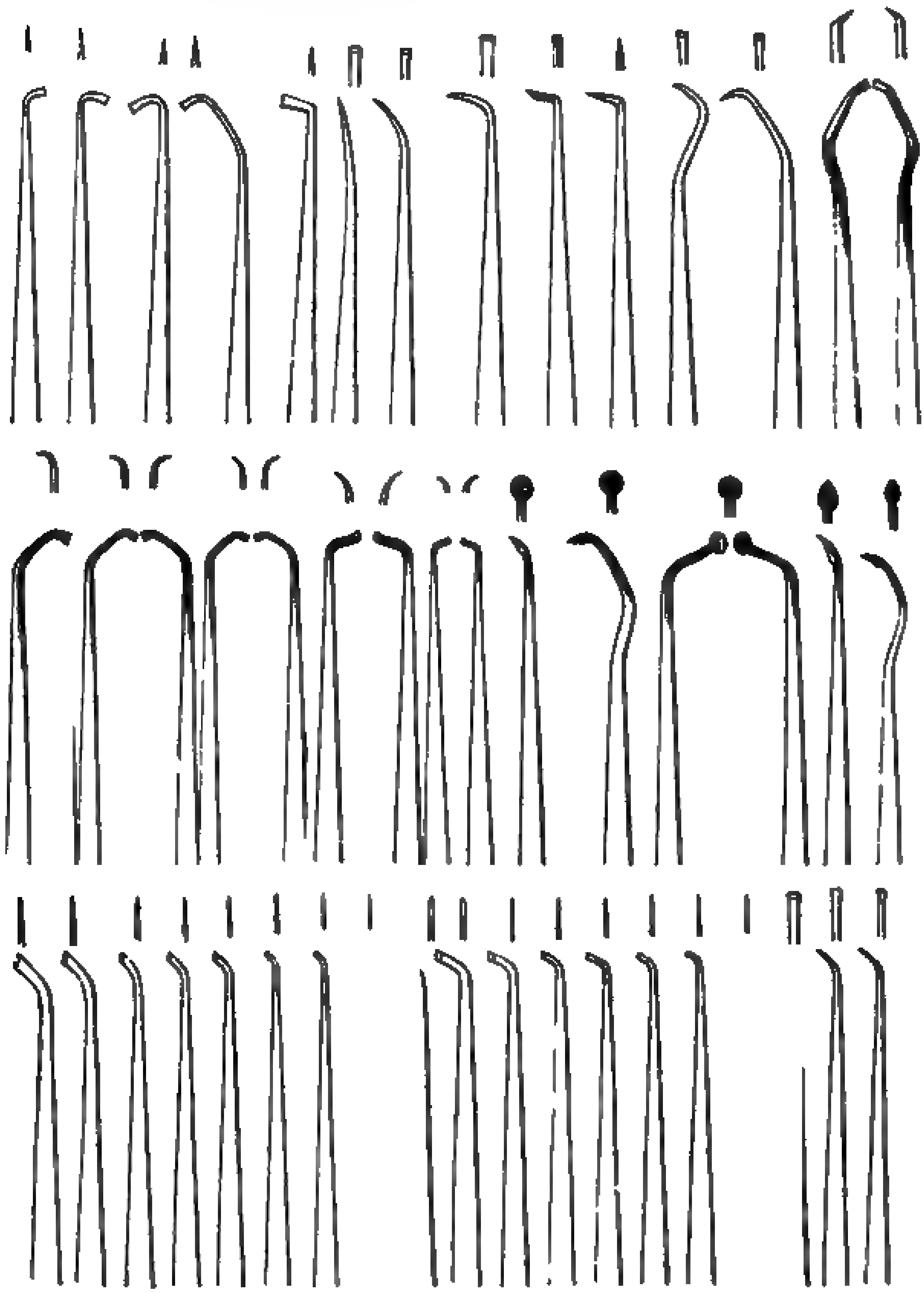
and gums is thrown into strong relief; the sound teeth will appear translucent and with no variations in texture, but a dead tooth will be at once detected by its opaque or dark appearance, even although to ordinary observation its color would indicate vitality. A cavity of decay, or any foreign substance about the teeth will show as plainly as a spot upon a window-pane. A healthy root will not be distinguishable from the membrane surrounding it; but caries of the pulp-canal or any thickening of the tissues will be brought out by the illumination.

For the examination of posterior cavities in teeth a mirror is attached to the guard in front of the lamp globe, forming a perfect apparatus for the purpose.

It has been found impossible, so far, to make the lamps of exactly equal power, but the variation is not great. To develop their full capacity requires about 3½ to 4½ volts—say the current from two to

three cells of a Bunsen battery. The cells of the battery supplied with the electro-magnetic mallet are excellent for the purpose, or three or four cells of any bichromate battery will answer.

FIG. 350.

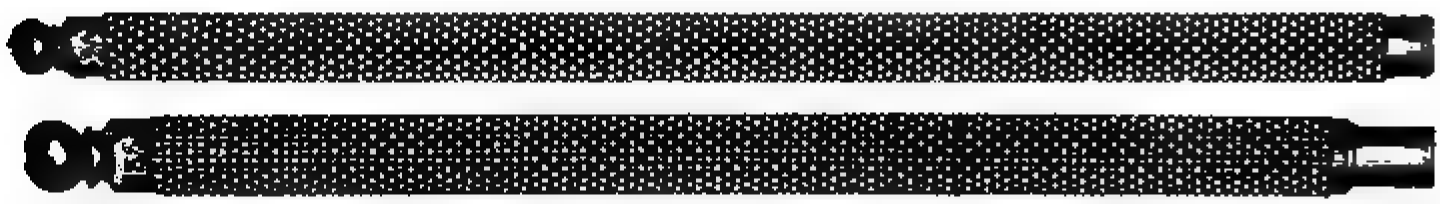


The circuit should be broken occasionally during a prolonged examination, and also whenever the lamp is not in use, to prevent its becoming so hot as to be unbearable in the mouth.

For the examination of posterior cavities a mirror, set at an angle of 45 degrees, is attached to the end of the guard. With the mirror attachment the electric mouth lamp forms a perfect laryngoscope.

INSTRUMENTS FOR FORMING THE CAVITY.—Fig. 349 represents a set of instruments called "Explorers," useful for examining the teeth to determine the presence of caries. For the removal of the diseased

FIG. 351.



part of the tooth and the formation of a cavity for the proper reception and retention of a filling, a variety of instruments are required, which should be constructed of the best steel and so tempered as to prevent them from either breaking or bending. Their points should be so shaped that they may be conveniently applied to any part of a tooth, and made to act readily upon the portion which it is necessary to remove.

FIG. 352.

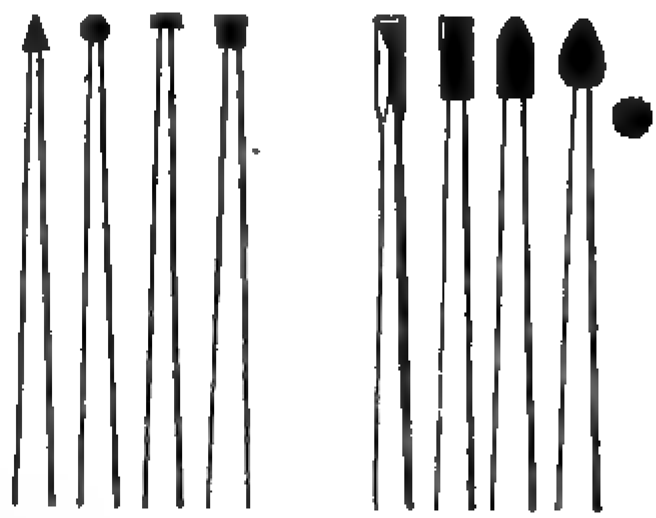
The instruments employed for this purpose are excavators and chisels. Fig. 350 represents some of the many forms of excavators in use, and Fig. 368, page 528, the various forms of chisel-excavators.

FIG. 353.

They may be formed either with handle and point in one piece or fitted to separate handles made of wood, ivory, pearl, or cameo, or be made to fit into one common socket handle. The introduction

of cone-socket handles has supplanted all other styles of socket-handle instruments. These handles are made of steel, nicely en-

FIG. 354.

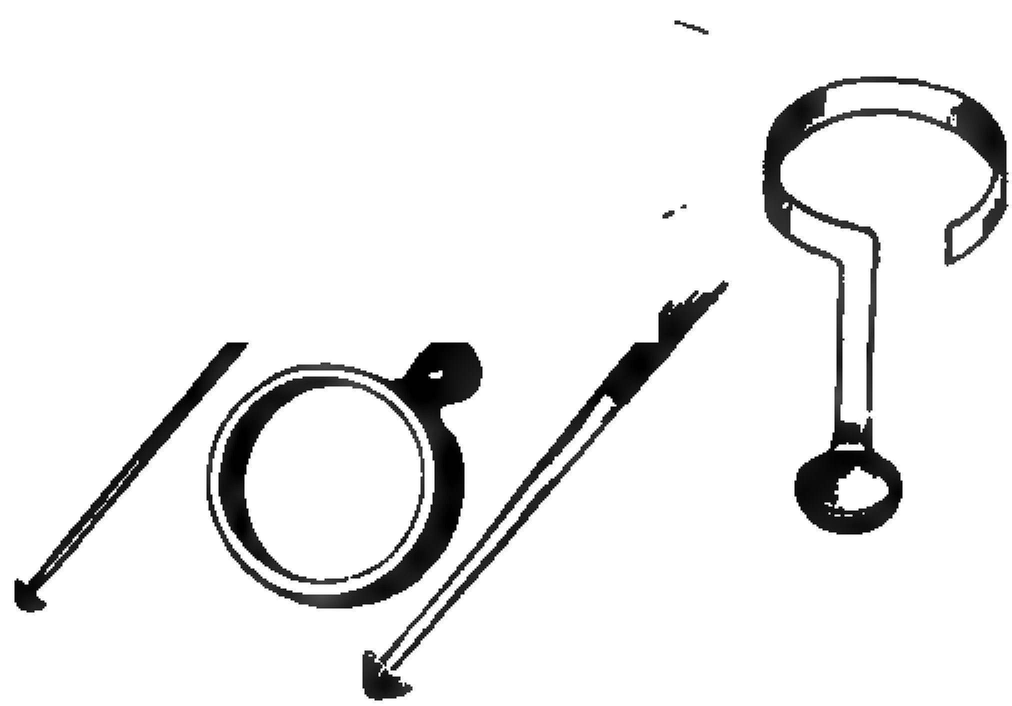


graved and nickel-plated. Fig. 351 represents such instruments.

Fig. 352 represents the form of plyers for screwing the points into the cone-socket handles.

Fig. 353 represents Dr. W. C. Head's approximal surface excava-

FIG. 355.



tors, intended chiefly for use in preparing cavities between the upper front teeth, working from underneath, but are also useful on bi-

cuspids where compound cavities are to be formed for contour fillings.

The flat and burr-headed drills represented in Fig. 354 are very useful for enlarging the orifice of a cavity. When hand instruments of this class are used the pressure of the instrument against the hand, between the thumb and forefinger, is often productive of much irritation, to prevent which a socket-ring or shield, like those represented in Fig. 355, may be used with advantage. It consists of a ring adapted for the fore or middle finger, with a small socket attached to the inside.

The use of excavating burrs, by means of the dental engine, has almost supplanted the separate-handle drills. Fig. 356 represents a variety of forms of excavating burrs and drills for use with the dental engine.

Fig. 356.

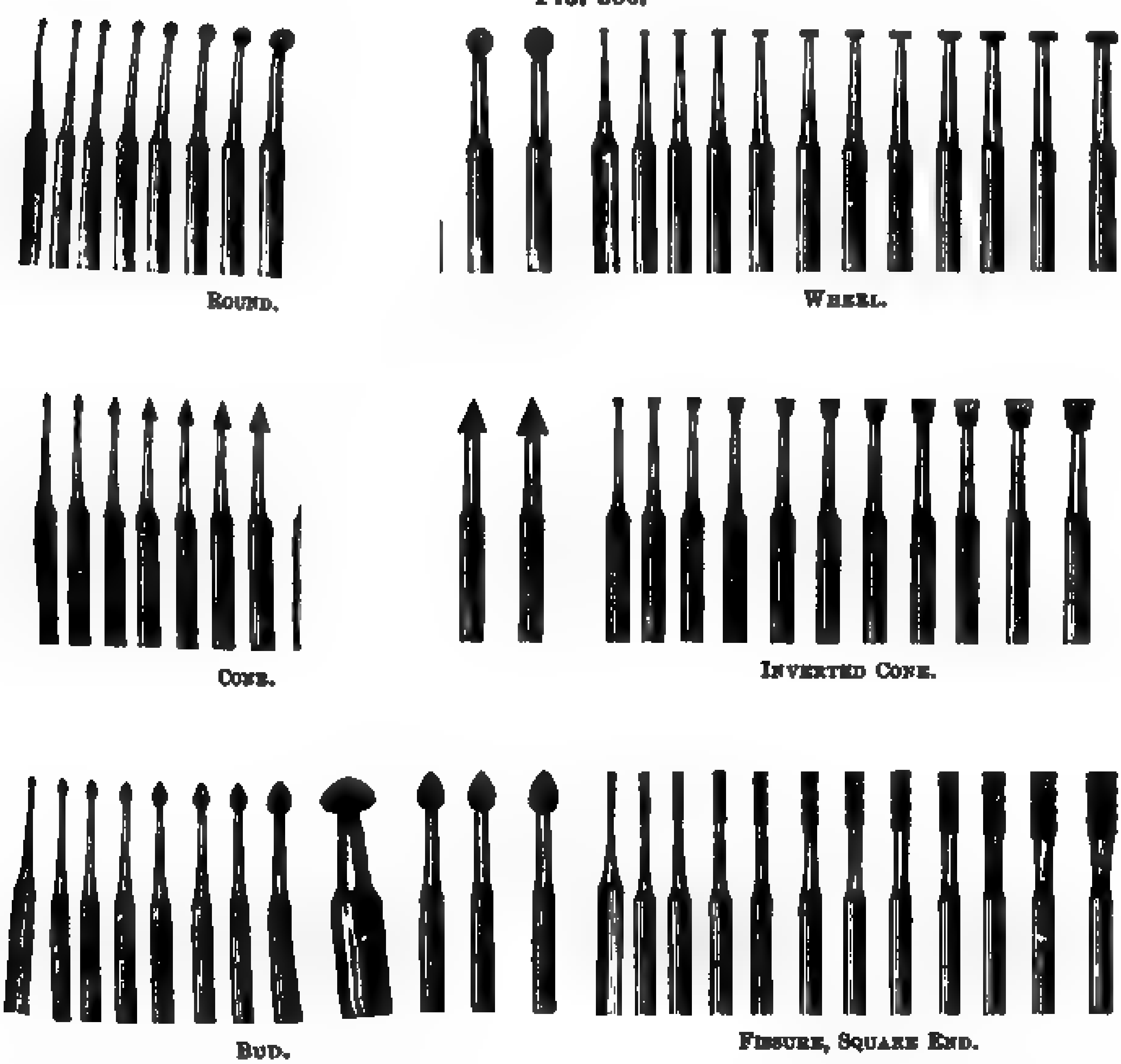
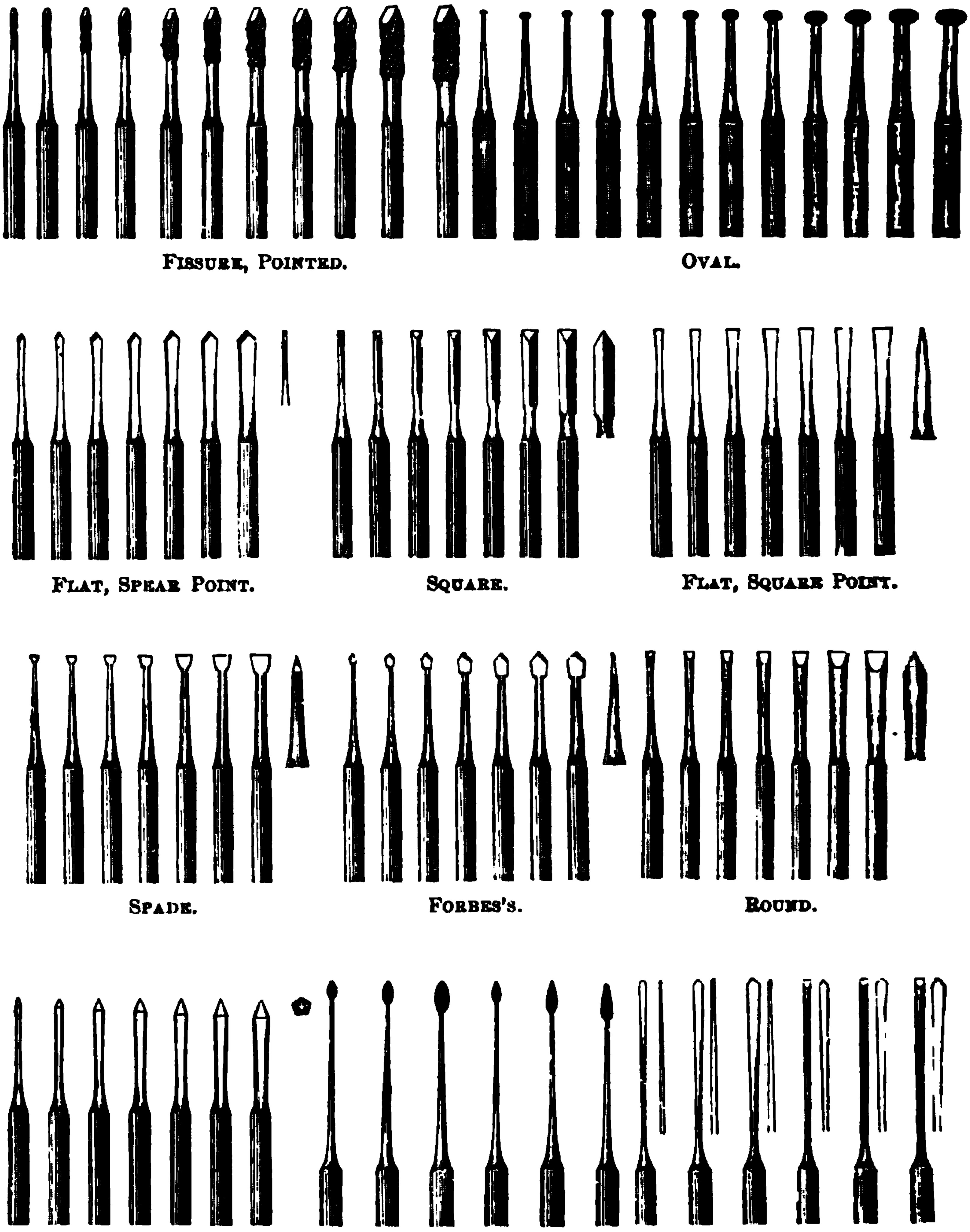


Fig. 356 (Continued).



Figs. 357 and 358 represent the S. S. White and Johnston styles of dental engines, a valuable invention, for which the profession is indebted to Dr. Morrison, of St. Louis, and by means of which instruments, such as burrs, drills, disks, condensing points, burnishers, wood-points, etc., are effectively employed.

Fig. 359 represents the S. S. White water-motor dental engine,

FIG. 357.

S. S. WHITE DENTAL ENGINE.

which can be run with from fifteen to twenty pounds pressure, and will make over 3000 revolutions per minute. The cable of an S. S.

Fig. 358.

Johnston Dental Engine.

White engine can be attached to a Backus, Tuerck, or other water-motor, which will make an efficient motive power.

Fig. 360 represents the Bonwill Dental Engine and Hand Piece.

Fig. 361 represents Dr. A. M. Holmes' device for the convenient

Fig. 359.

oiling of the engine bits, and its use will also keep the hand-piece in good condition.

Fig. 360.

Bonwill Dental Engine.

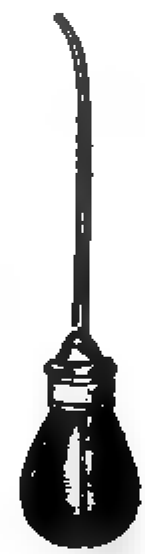
Fig. 362 represents a revolving stand for engine bits, disks, etc.

Fig. 363 represents a rubber bulb chip syringe, for blowing the cuttings and dust from cavities by means of cold air.

Fig. 364 represents an elastic bulb syringe for cleansing cavities. The bulb is first compressed, and the point is then inserted under water, when it fills itself.

A three-sided instrument brought to a point (Fig. 365), as also a chisel-edged (Fig. 366), and a four-sided one with a cutting edge

Fig. 361. Fig. 362. Fig. 363. Fig. 364.



(Fig. 367), may often be used advantageously in cutting away portions of enamel to enlarge the orifice. These instruments are now almost entirely superseded by the use of the variously-shaped burrs and drills to be used with the dental engine (Fig. 356). Enamel chisels of other shapes, and gouges, are also very valuable instruments for

Fig. 365.

Fig. 366.

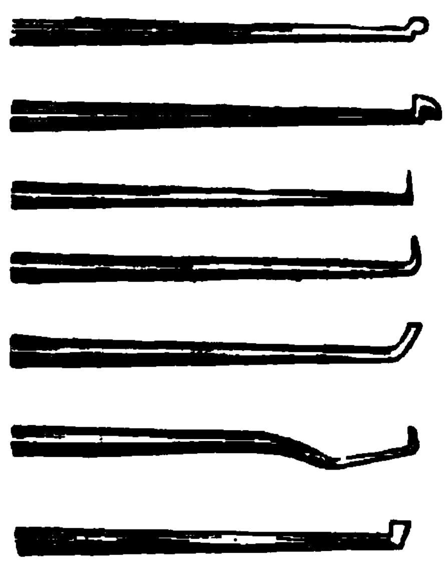
Fig. 367.

the preliminary operation of opening large cavities or cutting off sound enamel or dentine whenever necessary (Fig. 368).

But the cavity can seldom be completed with either of the instruments mentioned above. After it has been opened and the orifice made sufficiently large, it should be finished with excavators (Fig. 350) and burrs (Fig. 356) properly adapted to the purpose; in fact, in the majority of cases it should be wholly formed with instruments of this sort.

Excavators, shaped like those represented in Fig. 350, have been found by the author to be as well adapted for the removal of caries as any which he has ever employed. There should be several sizes of each shape; also duplicates of each instrument, to prevent delay in case of accident while operating. As the proper formation of the cavity greatly depends on having suitable instruments, every operator should be provided with a large supply of burr drills and excavators, so that he may never be at a loss for such as the peculiarity of any case may require. He should also have the material, and know how, in an emergency, to point his own excavators. For this purpose he will need a lamp, a small anvil and hammer, a set of fine-cut files, such as are used by watchmakers, and an assortment of steel rods of various sizes and of the best quality. It is not our purpose to give specific directions for working steel, but we would offer two cautions: first, small points quickly become brittle by hammering and need frequent annealing; second, steel is greatly injured by raising it to a full red or white heat. A very fine temper may be given, after shaping the point, by heating to redness and suddenly plunging it in wax or tallow.

Fig. 368.



As excavators must be kept very sharp, an oil-stone should be constantly at hand. The Arkansas, Hindostan, or Superior stones are superior for this purpose to all other varieties, on account of their hardness, fineness, and sharpness of grit.

Manner of Forming the Cavity.—The preparation of the cavity in a tooth for the reception of a filling is a very essential part of the operation, and, though usually the easiest, is sometimes attended with much difficulty. The removal of the diseased part is sometimes all that is necessary preparatory to the introduction of the gold, but in the majority of cases the cavity must be so shaped as, when properly filled, to retain the filling in place.

Where the orifice to a cavity is small and contracted it should be enlarged, by means of a burr drill, sufficiently to allow the use of excavators to remove the softened dentine. Small cavities may not only be enlarged, but cleaned and formed, by the drills.

Some prefer excavators in the form of scoops, for the removal of the softened dentine, which should be completely removed, and a dense, normal surface reached, due regard being had to avoid injury to the pulp of the tooth. A knowledge of the anatomical structure of the teeth will enable the operator to avoid penetrating to dangerous points when excavating cavities. Burrs operated by the dental engine can

be applied at almost any angle, and prove very serviceable in preparing cavities for fillings.

The part of the tooth surrounding the orifice should present no rough or brittle edges. The size of the bottom of the cavity should be as near that of the orifice as is possible, even a little larger, rather than any smaller. But the difference between the size of the one and the other should never be very great; for if the interior of the cavity is much larger than the orifice, it will be difficult to make the filling sufficiently firm and solid to render it absolutely impermeable to the fluids of the mouth.* If, on the other hand, the orifice is larger than the bottom of the cavity, it will be difficult to obtain sufficient stability for the filling, so as to prevent it from ultimately loosening and coming out. It often happens, however, that the situation and extent of the decay is such as to render it impossible to make the cavity so large at the bottom as at the orifice; when this is the case, several pits or circular grooves should be cut in the inner walls, for the purpose of obtaining as much security for the filling as possible; being careful to make these in the dentine rather than in the enamel, which is so much more brittle. By proper attention to this precaution, a filling may be so inserted in this difficult class of cases as to prevent it from coming out.

As a general rule it is easier to form a cavity in the grinding surface of a molar or bicuspid than in any other position; though it sometimes happens that even here it is attended with difficulty, and especially when the decay, commencing in the centre, follows the several depressions which run out from it. In such cases the edges bordering on and covering the affected parts, which are often thick and very hard, should be cut away, together with the subjacent decayed dentine; the radiating depressions should open fully into the central cavity, and be made sufficiently wide and deep to admit of being filled to their extremities in the most perfect and substantial manner. The surface of a filling occupying a cavity of this kind presents a sort of stellated appearance. When two or more decayed places are separated only by very thin walls of tooth-substance, these should be cut away, and a cavity formed large enough to

* Place a lump of cotton in the hollow of the hand formed by bringing the ends of the fingers against the palm. Then press with an instrument upon the centre of the cotton, and it will leave the sides of the cavity. This simple illustration, suggested by Dr. Edward Maynard, will explain the cause of failure, in certain cases which have come under his notice, from the hands of operators of deservedly high reputation. The cavity, smallest at the orifice, had been well filled; but the final compression upon the centre had drawn the gold from the sides, thus permitting the access of fluids, and ultimately decaying the tooth around the filling.

include all the diseased points; as one large filling will secure the preservation of the tooth more effectually than by filling each cavity separately.

Sharp angles should be avoided, as far as possible, in the outline of the orifice of the cavity, because of the extreme difficulty of filling them compactly. The orifice must also have a firm, decided margin, with no thin projecting edges of enamel on the one hand; with no countersunk depressions on the other. In the first case the thin enamel is apt to break off either during the operation or subsequently; in the second case the thin scale on the edge of such fillings breaks away in the course of time; in both cases the filling fails perfectly to answer its purpose in the preservation of the tooth.

The enamel edges of every cavity, in preparing it for the introduction of a filling, should be smoothed by means of enamel chisels or the margin chisels, or the stone wheels and points, so that it may be somewhat countersunk. Too much care cannot be taken to properly prepare the enamel edges, as the perfection of the filling depends in a great measure upon the adaptation of the gold to such edges or margins.

It is preferable, in many cases of front approximal fillings, to cut away the inner angles of the tooth, thus avoiding the injury to the external appearance of the tooth caused by the file, etc. Upon completion of the operation, the surface thus cut is perfectly polished, as every filled or cut surface upon the teeth should be, and so shaped as to be kept readily cleansed with the brush or with floss silk. It is also very important that all the edges of cavities should be smooth and polished before and after the introduction of the filling.

All *débris* accumulating during the cutting away of softened dentine and the formation of the cavity should be removed, either by the syringe with tepid water, or blasts of air, the latter being preferable where it is desirable to keep the cavity dry during the entire excavation.

In forming a cavity for the reception of cohesive gold foil, it is very necessary that it should be of such a shape as to retain securely the first gold introduced, and to accomplish this one or more small cavities, called retaining points, are made within the larger cavity. These retaining points in many cases afford anchorage for the entire mass of gold composing the filling, and in every case where these forms of gold are used, they are the support in the building up from the bottom to the orifice of the cavity.

These retaining points are formed in the dentine by means of a small, square, chisel-edged spear, or spear-shaped drills, and can very often be made of one-sixteenth of an inch in depth; a less

depth, however, will answer in many cases. One of these retaining points in connection with one or two under-cuttings on the opposite

Fig. 369.

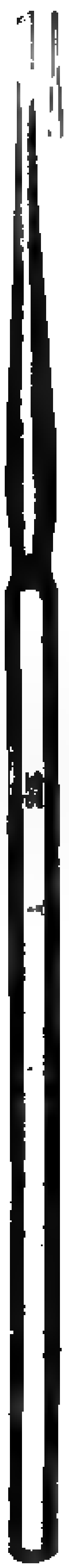


Fig. 370.

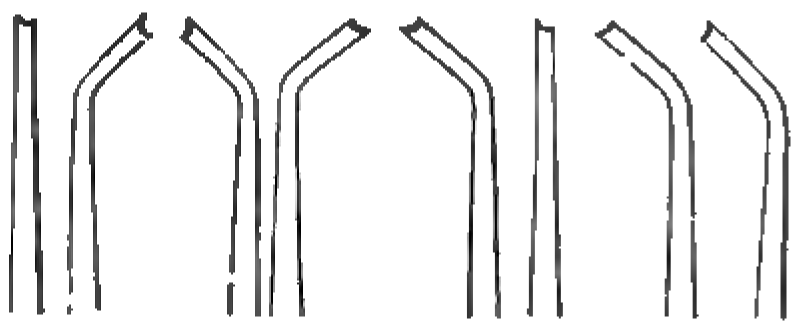
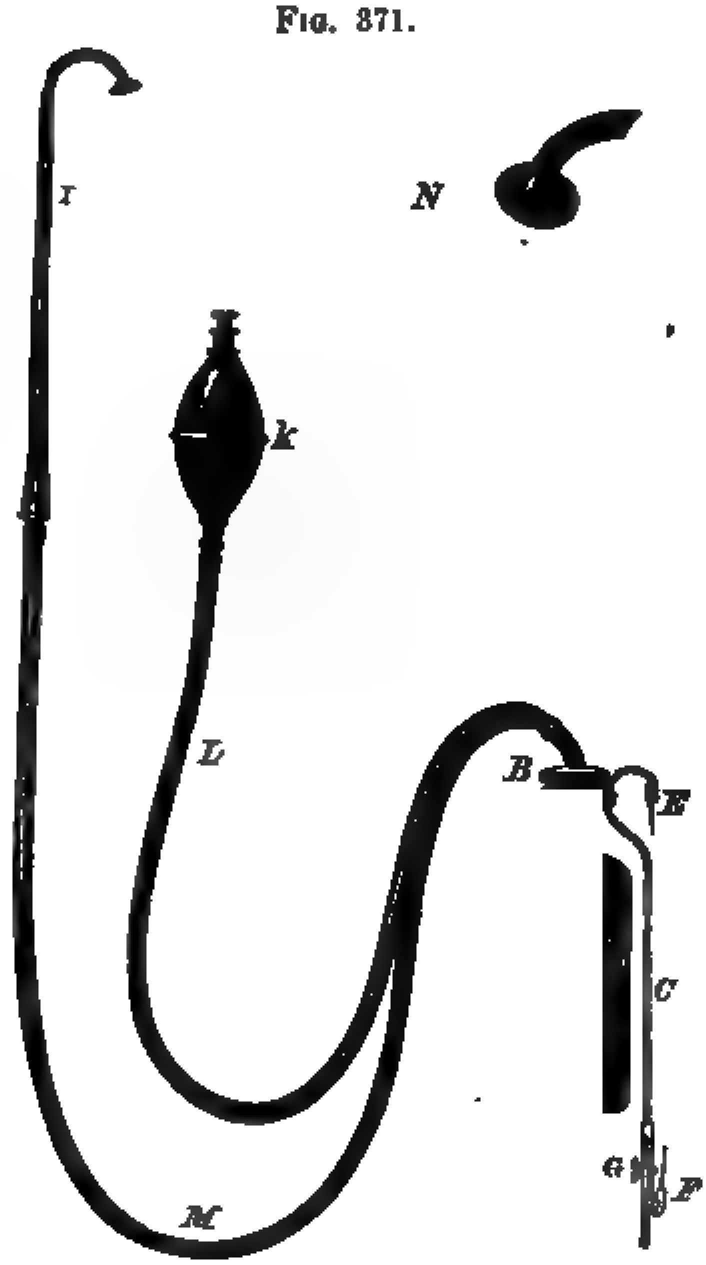


Fig. 371.



wall will be sufficient in some cavities, while in others two or three are required. The gold should be introduced into these retaining

points in such a manner as to form, when they are filled, solid masses of metal, which would require considerable force to dislodge them. Upon these solid masses the gold filling the cavity is built.

Fig. 369 represents a set of Dr. E. S. Talbot's Margin Chisels and Pluggers, for cutting, rounding, and smoothing the edges of cavities, leaving them in a condition to receive the gold, which should be adapted accurately to the margins.

Protecting Cavities from Moisture.—The first step in this operation is to wipe the mucous membrane covering the parts about the tooth to be filled perfectly dry, as well as the mouth of the duct of the nearest salivary gland, from which saliva may flow in such a manner as to interfere with the operation of filling the cavity. Before the introduction of the rubber-dam the following method was pursued, to protect cavities from moisture: Over the mouth of the duct a roll of bibulous paper was placed, upon which rested one part of a napkin, which was so arranged about the tooth as to prevent the mucous secretions from reaching the cavity. The napkin was held in place by the thumb and fingers of the left hand. The remaining portion of the napkin could be used to prevent the breath from coming in contact with the material used for filling, as well as the cavity. When this was accomplished, the cavity was dried, as hereafter described, and was then ready for the filling. Much more difficulty was met with in protecting cavities in the inferior teeth from moisture than in the case of the superior, and various applicances were devised to overcome it.

The common saliva pump (Fig. 370) is used to remove the saliva as it accumulates in the lower part of the mouth, and consists of a glass tube with an elastic bulb.

Fig. 371 represents a very superior saliva pump. *A*, bottle or reservoir. *C*, clamp, furnished at its upper and lower ends with eight steel pins, *E*, *F*, to secure it to the upholstery of a chair, so that it cannot be detached by accidental force. When used, the hard-rubber mouth-tube, *I*, is held in the mouth by one hand of the patient, and the bulb, *K*, in the other. Whenever saliva accumulates, the patient presses the bulb, and the saliva flows into the reservoir. The reservoir is emptied by unscrewing the cap, *B*. A very ingenious improvement on this instrument has been recently made for attachment to the "fountain spittoon," the current of the water causing a constant automatic suction, by which the instrument is operated and the mouth kept free from saliva.

Fig. 372 represents the Adjustable Fountain Spittoon with the Saliva Pump attachment.

Fig. 372.

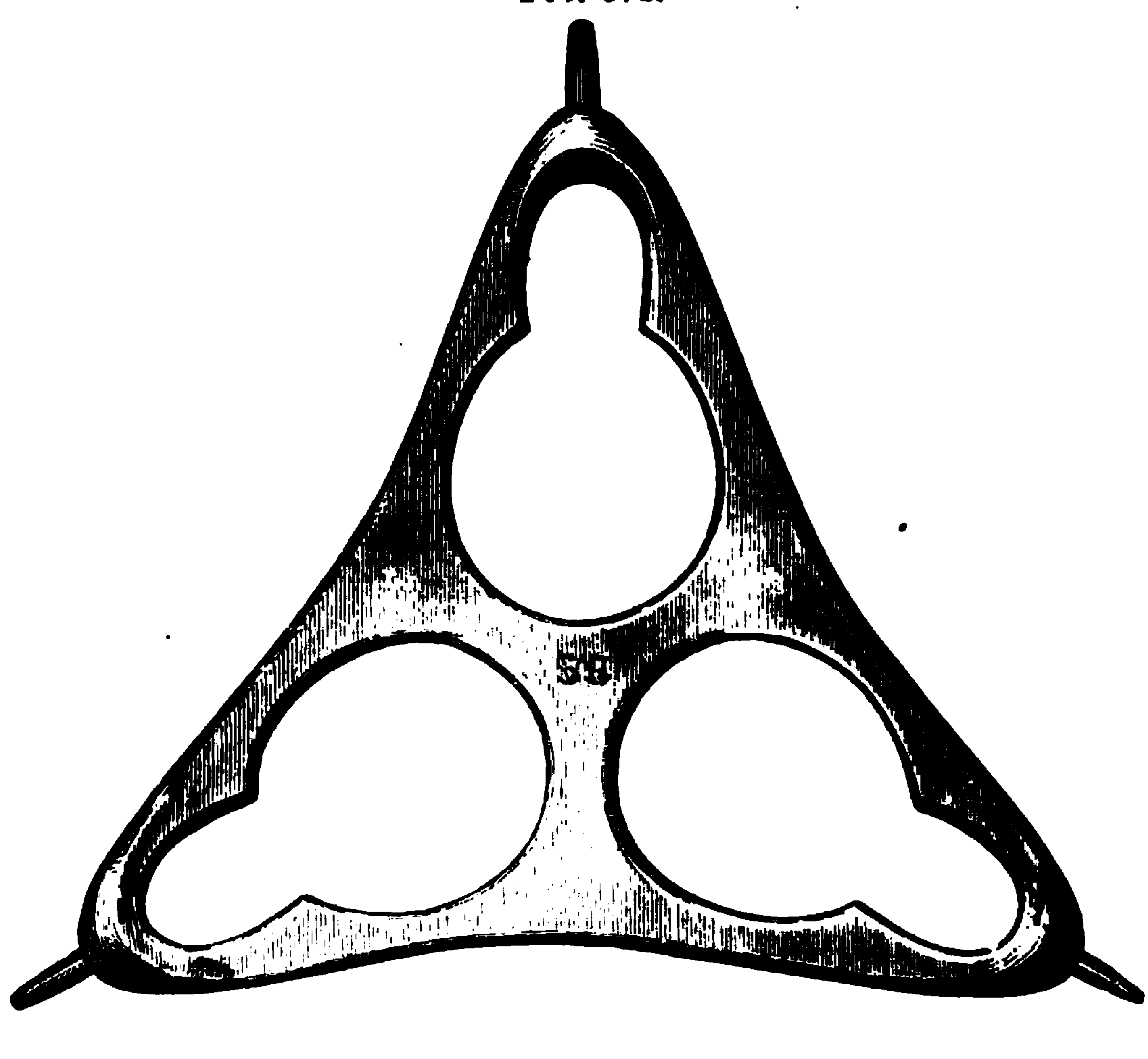
The Rubber Dam.—For one of the most simple, yet effective, appliances for controlling the flow of saliva and protecting cavities from moisture we are indebted to the late Dr. S. C. Barnum. It consists of nothing more than a thin sheet of India-rubber, of good quality that it may possess sufficient strength and not tear easily, and of a thickness double that of letter paper.

Some distance from the edge of the sheet, which is from four to eight inches square, one, two, or more holes are made, through which the crowns of the teeth are passed when it is applied to the mouth.

The holes made in the rubber should be about one-tenth smaller in diameter than the necks of the teeth they are to embrace.

Fig. 373 represents the Rubber Dam in position supported by means of a "dam-holder" devised by Dr. Cogswell.

FIG. 374.



It is better in all cases to make several of these holes in the sheet, in order to include within the coffer-dam formed when the sheet is in position the crowns of the teeth adjoining the one in which the cavity to be filled is situated. When the crowns of the teeth approximate closely the holes should be made about one-eighth of an inch apart; if some space exists between the crowns the holes may be made at a greater distance from each other. These holes may be formed in the rubber by means of a small chisel-edged punch, by

Fig. 375.

Fig. 376.

Ainsworth's Rubber-Dam Punch.

burning with a heated instrument, or by the appliances represented in Figs. 374, 375, 376, and 377.

The rubber, thus prepared, is carried between the teeth by either a thin, flat burnisher, or, which is better, by waxed floss silk, and the

FIG. 377.

THE GUIDE RUBBER-DAM PUNCH

margins of the holes pressed gently under the free edges of the gums, in the direction of the roots of the teeth.

These margins should be secured to the necks of the teeth by means of waxed floss silk tied around them, or by the use of suitable clamps, such as are now manufactured for that purpose.

FIG. 378.

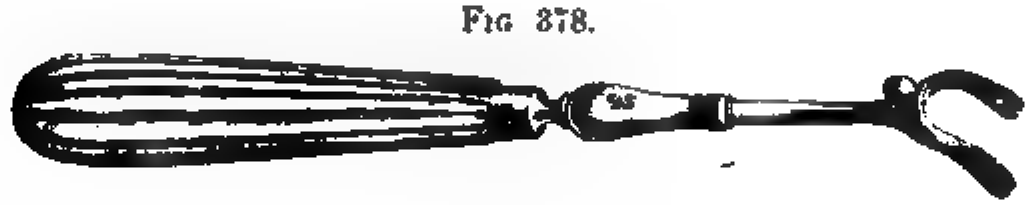


Fig. 378 represents an "Applier" for the use of waxed floss silk in adjusting the Rubber Dam.

Fig. 379 represents some of the many forms of Rubber-Dam Clamps used for securing the rubber dam to the necks of teeth.

Forms of these clamps are made with tongue-guards, such as are shown in Fig. 380.

Fig. 381 represents the Rubber-Dam Clamp Forceps, by means of which the clamp, in connection with the rubber dam, is placed in position on the tooth.

Fig. 379.

Fig. 382 represents Dr. E. Parmly Brown's Universal Rubber-Dam Screw-Clamp, which may be adjusted to any tooth in the mouth,

Fig. 380.

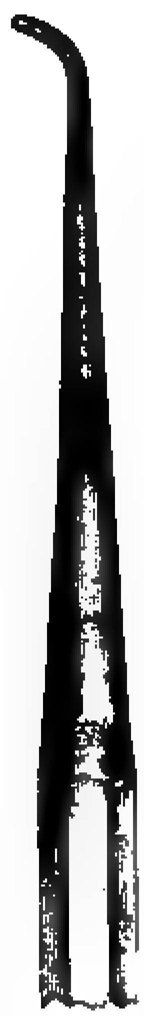
clasping several teeth at the same time, and is applicable to loose or tender and not fully erupted teeth.

Several other simple appliances are in use to protect cavities from

Fig. 381.

moisture, such as wooden wedges forced between the necks of the teeth, and waxed cord surrounding the tooth in which the cavity is situated, and passing to an adjoining tooth; also a band of rubber cut from tubing, which is placed high up on the neck of the tooth and then carried around an adjoining one. Two of these bands, acting in opposite directions, answer better than a single one, and in many cases effectually protect the cavity from moisture.

FIG. 362.



Drying Cavities.—After every particle of decomposed dentine has been removed, the cavity should be thoroughly cleansed before the filling is introduced. This may be done by first injecting tepid water into it with a properly constructed syringe, and afterward wiping it dry with a small lock of absorbent cotton fixed upon the point of a probe or excavator; or the cavity may, in the first place, be wiped with a little raw cotton moistened with water and afterward with absorbent cotton. The application of the cotton should be followed by that of Japanese bibulous paper, which has a very loose, absorbent texture, and may be folded, for convenience, in the form of a rope, from which the moistened end can be torn after each insertion. Tissue or bibulous paper absorbs moisture more perfectly than cotton. The absorbing qualities of cotton, however, may be increased

by boiling it for fifteen or twenty minutes in a tolerably strong alkaline solution; this done, it should be thoroughly dried before using; or by saturating it with sulphuric ether to remove the natural oil. Several materials have been of late years used in drying cavities, such as prepared flax, fine and white, with a long, absorbent fibre, prepared spunk, absorbent cotton. Fig. 383 represents a Hot-air Syringe for drying cavities. To fill this syringe with heated air, the turret of the air-chamber is held in the flame of a spirit-lamp; the turret, being provided with a metallic valve, recedes as the bulb, after being compressed, fills with air and allows the flame to be drawn into the

FIG. 383.

chamber; the air-chamber is divided by partitions of wire gauze, which act as retainers of heat. It is desirable that the cavity should be perfectly dry before the filling is introduced.

INSTRUMENTS FOR INTRODUCING AND CONSOLIDATING GOLD.

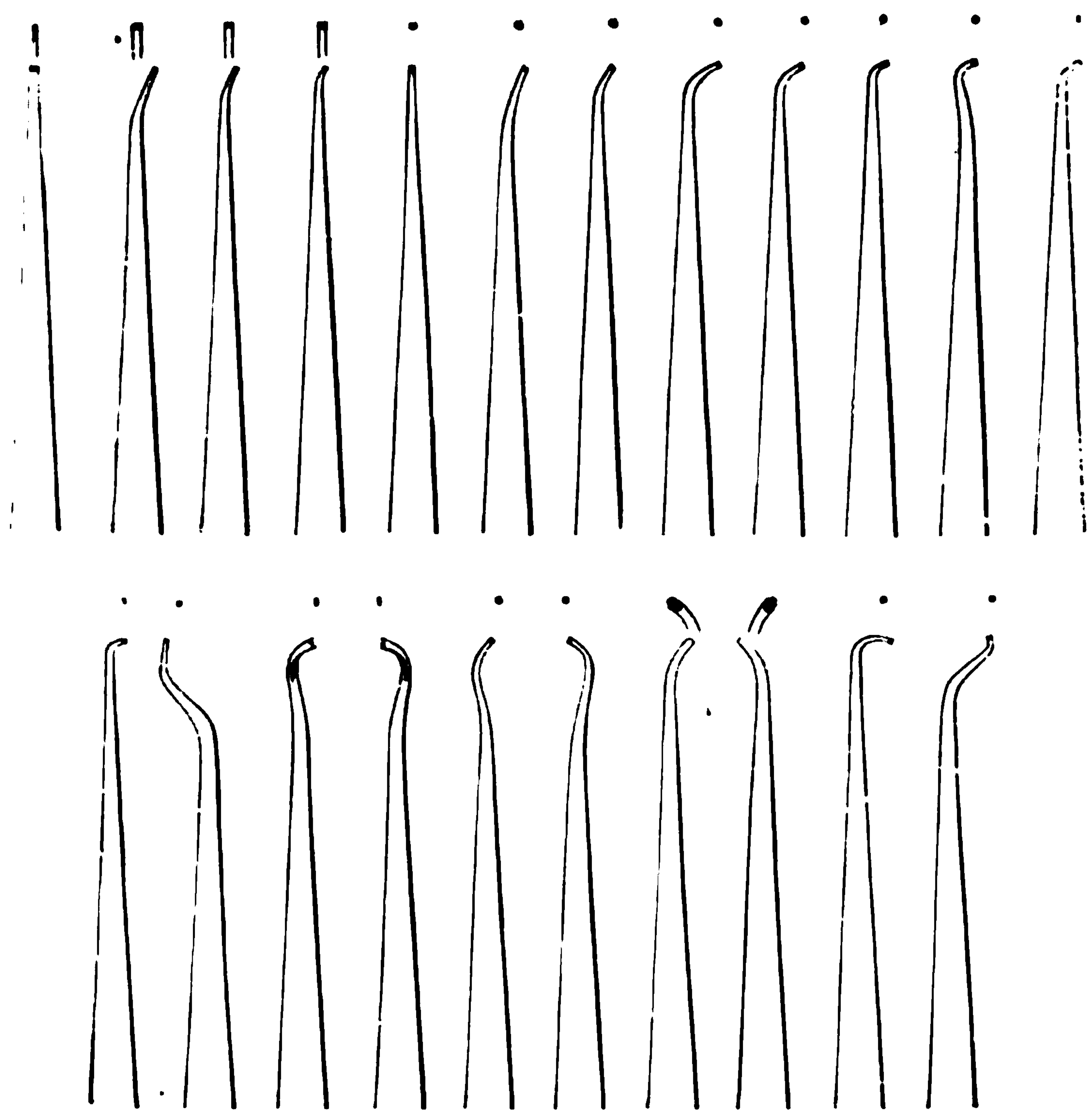
For introducing and consolidating non-cohesive gold foil, a number of instruments are required, which should be sufficiently strong to resist any amount of pressure the dentist can safely exert in the operation. Hand instruments should have round or octagonal handles, large enough to prevent the liability of being broken and to enable him to grasp them firmly. Their points should vary in size, though none should be very large. Several should be straight, but for the most part they require to be curved—some very slightly, others forming with the shaft of the instrument an angle of 90° Fig. 384 represents a set of small-pointed hand pluggers. For other forms the reader is referred to the chapter on "Filling Individual Cavities."

Plugging instruments, as received from the instrument makers, have usually a temper which will not permit them to be bent. It will add, we think, greatly to the value of the instrument if the practice of Dr. Maynard were more generally adopted. He gives to the extreme point a hard temper (straw color) to prevent it from wearing; for a little distance, say one to three-quarters of an inch.

a spring temper is given (purple or blue color) to insure strength when the shape is delicate; the rest of the instrument is left soft, so as to admit of being bent (with pliers) in the direction best suited for that particular point in any given operation.

Most of them should have a slim wedge shape; some, however, both of the straight and curved instruments, should have blunt serrated points, and a few should have highly polished oval points, for finishing the surface of fillings. Formerly, most dentists employed,

FIG. 384.



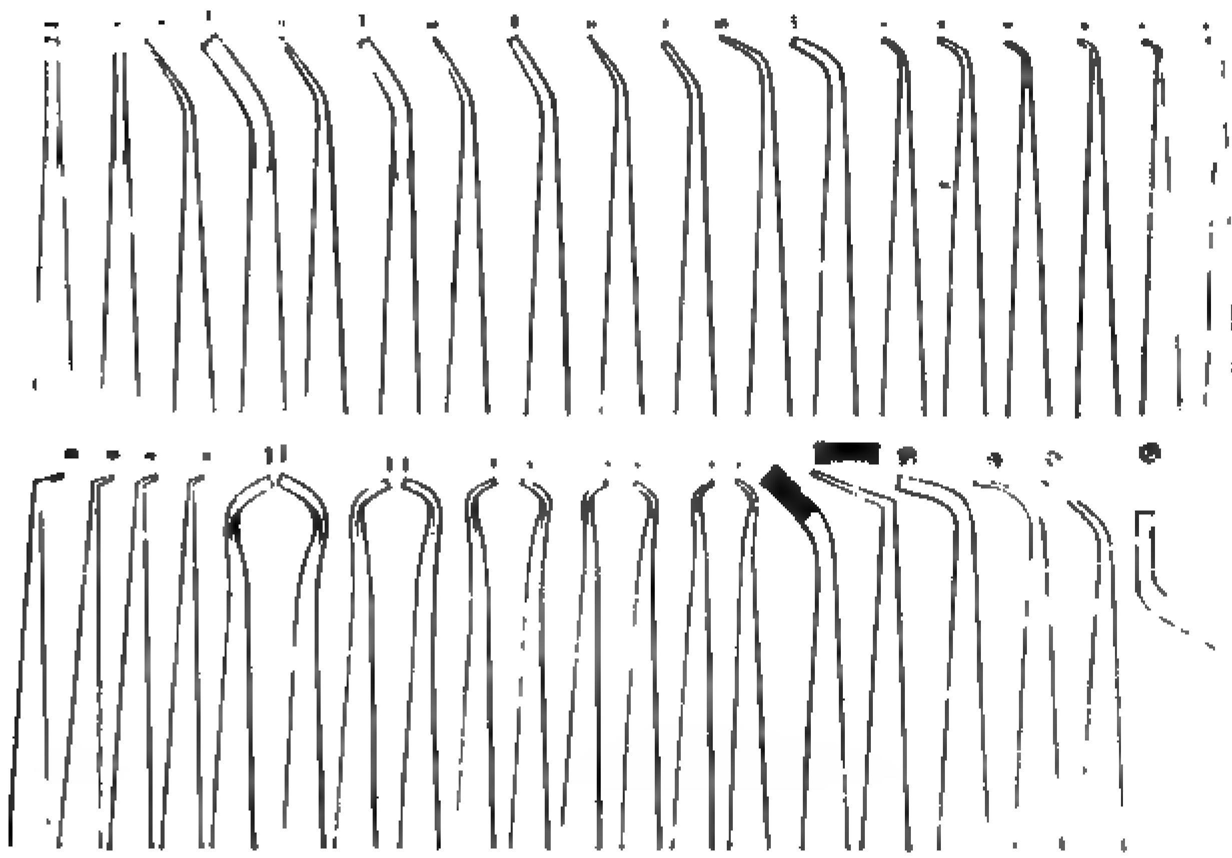
for introducing and consolidating the gold, simple blunt-pointed pluggers; but it is impossible with such instruments to make a filling as firm and solid as it should be for the perfect preservation of a tooth, especially if the cavity is large. From one-fourth to one-half more gold can be introduced into a tolerably large cavity with a wedge-pointed than with a blunt pointed instrument.

Fig. 385 represents an excellent set of points designed by Professor James H. Harris for use in solid or socket handles, and also

with the automatic or hand mallet, and although intended for cohesive gold, can also be used for the non-cohesive.

This general description will serve to convey a tolerably correct idea of the kind of instruments required for the operation.

Fig. 385.



Instruments having serrated points are required for filling teeth with crystal or sponge gold and with cohesive gold foil.

Fig. 386.

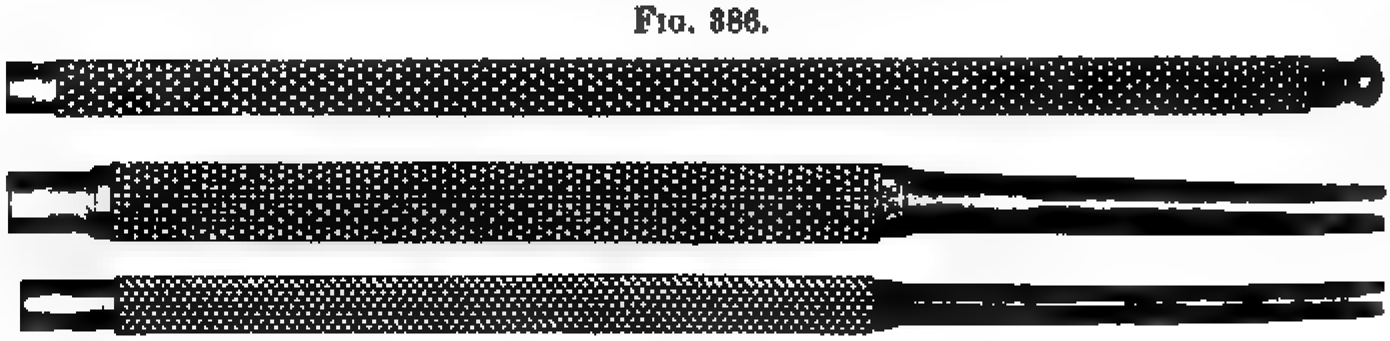


Fig. 386 represents some knurled handles for cone socket plugger points.

Fig. 387 represents Dr. R. W. Varney's set of Pluggers for the cohesive form of gold foil.

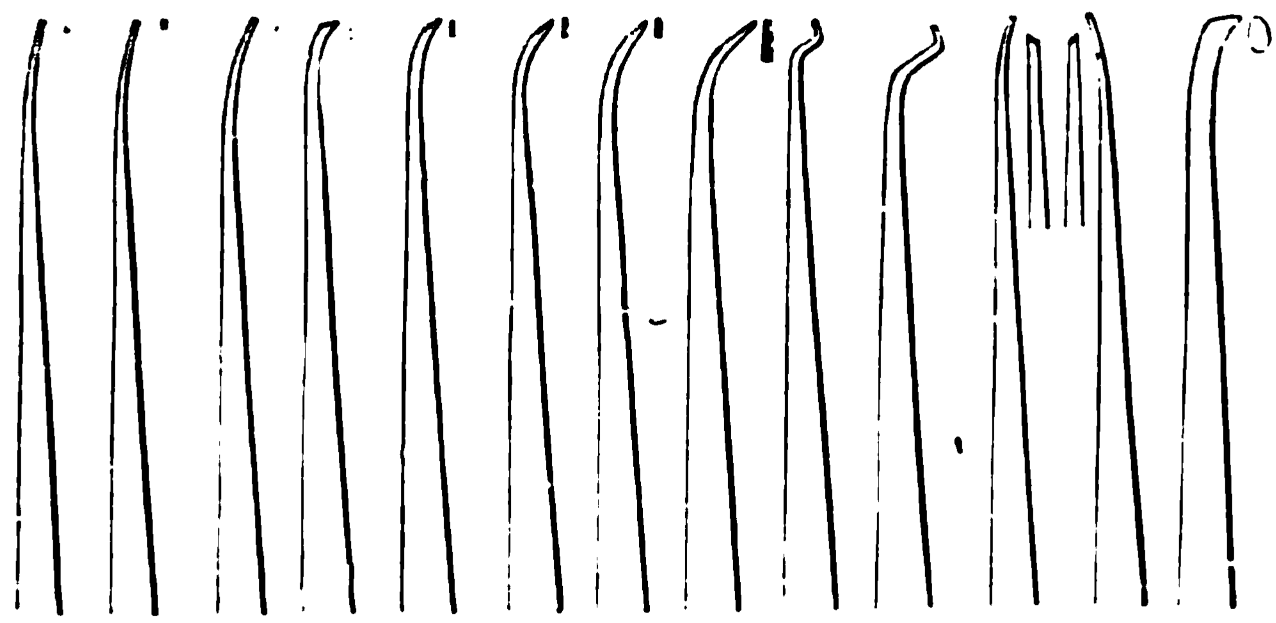


Fig. 387.

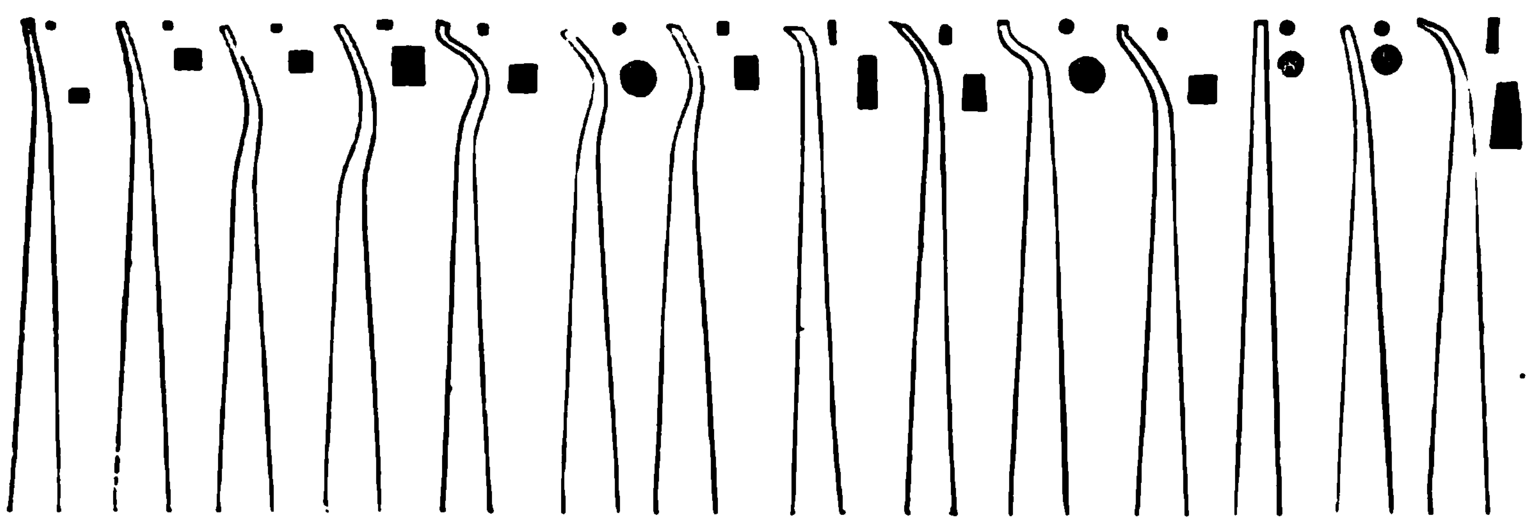


Fig. 388.

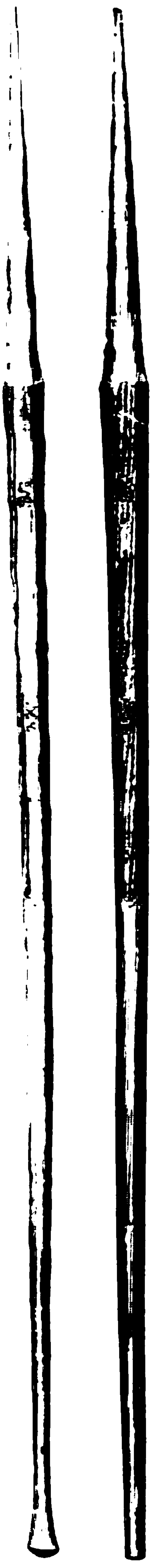


Fig. 388 represents Dr. Marshall H. Webb's set of pluggers, also for the cohesive form of gold foil.

Fig. 389 represents Dr. Chapelle's malleting shaft pluggers, for the use of cohesive gold, especially No. 30 rolled cohesive gold, cut in strips $\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$ inch wide and one inch long.

Fig. 390 represents a combined foil carrier and plugger, for taking up pieces of gold and placing them in the cavity and partially condensing them.

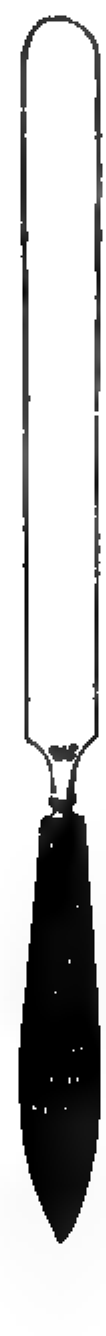
MANNER OF PREPARING, INTRODUCING, AND CONSOLIDATING GOLD, AND FINISHING THE SURFACE OF THE FILLING.

Non-Cohesive Gold Foil.—The operator, being provided with the necessary instruments, should cut this form of gold with a pair of foil-scissors into strips containing from one-fourth of a sheet to one whole sheet. Each of these should be loosely rolled or folded together lengthwise, by the aid of a foil-holder or spatula (Fig. 391), on a piece of soft spunk, covered with chamois skin or white kid—the foil-scissors and spatula have recently been combined into one

Fig. 389.

Fig. 390.

Fig. 391.



instrument—and after the cavity has been properly cleansed and dried, the end of one fold should be introduced and carried to the bottom of the cavity, with a straight or curved wedge-pointed instrument; the roll on the outside should then be folded on the part first inserted. The folding should be commenced on one side of the cavity, and the inner end of each fold taken to the bottom, the outer extending nearly a twelfth or an eighth of an inch on the outside of the orifice; thus, fold after fold is introduced, until no more can, in this manner, be forced into the cavity. Having proceeded thus far in the operation, the instrument should be forced through the centre of the filling and the gold firmly pressed against the walls of the cavity. The opening thus made should be filled in the manner as first described, and this time it should be packed in as tightly as possible. This done, the operator should endeavor to force a small, wedge-pointed instrument in the centre of the filling, until he has tried every part of the plug, filling, as he proceeds, every opening which he makes, and exerting, in the packing of the gold, all the pressure which he can apply without endangering the tooth. If one roll or fold of gold is not enough, he should take another and another, until the cavity is thoroughly filled. When the walls of the cavity are frail it is the practice of some operators to introduce the gold rather loosely, and to depend upon surface condensing to obtain the necessary solidity. But it is better to well condense every fold immediately after it is carried to its proper place in the cavity; such condensing will often render the use of the wedge-shaped instrument unnecessary.

The advantage to be derived from introducing the gold in this manner is obvious. By extending the folds from the orifice to the bottom of the cavity the liability of the gold to crumble and come out is effectually prevented, and by introducing it with a wedge-pointed instrument it may be carried into all the depressions of the walls of the cavity, and rendered altogether more solid than it could otherwise be made. The cohesiveness of the gold may be increased by slightly warming in the flame of a spirit lamp, after it has been made into rolls or folds.

After the cavity has been completely filled, every portion of the projecting part of the gold must be thoroughly consolidated, before it is allowed to become wet, with a small, blunt-pointed instrument, straight or curved, as may be most convenient; or, if the filling is in the approximal side of a tooth, it may be compressed with the angle of the point of the plugger, making the adjoining organ, to a

slight extent, a kind of fulcrum for the instrument. After the filling has been thus consolidated as long as it can be made to yield in the least to the pressure of the instrument, the protruding parts may be scraped or filed off, down to the tooth, so as to form a smooth, uniform, gently swelling, or perfectly flat surface. Fig. 413 (p. 562) represents a number of finishing files. If in this part of the operation any portion of the gold should crumble or be dislodged, which it will not do if it has been properly introduced and consolidated, the injury may be repaired by making, in the part of the plug where it has occurred, an opening, and filling it, or by the removal of the whole of the filling and the introduction of another. If any portions of gold have been forced over the edge of the orifice of the cavity they should be carefully removed, either with a file or sharp-pointed cutting instrument suited to the purpose. This precaution should never be neglected, especially when the filling is in the approximal surface of a tooth, where a portion of the gold is very liable to be forced up or down upon the neck and under the gum. If the filling is located on a masticating surface, a flat and level gold surface will answer the best purpose in preserving the tooth-structure; if upon an approximal surface, the filling should be contour, as a general rule. Soft or non-cohesive gold foil, in the form of the ribbon or loosely-rolled cylinders, is frequently used in connection with cohesive gold foil as a base upon which to build the latter form of gold. This combination is especially applicable in the case of cavities upon the approximal surfaces of the teeth and which extend to the gum. The soft or non-cohesive gold in such cases is employed to cover over the cervical walls, being first introduced into one of the angles of the cavity, until this wall is completely covered, when mallet force is employed to condense the mass which has been introduced, with a fine foot-plugger. On this base of non-cohesive gold, pieces or pellets or the ribbon of cohesive gold are condensed, and the filling completed with the latter form of gold. The non-cohesive gold, owing to its quality of adaptability, is capable of being closely packed against the most vulnerable walls of cavities, where it answers a better purpose in the preservation of the teeth than the cohesive forms would do in the same location.

Cylinder Filling.—The method of filling cavities with non-cohesive gold foil in the form of cylinders is a favorite one with many operators, and is in some cases, especially grinding surface cavities with firm walls, preferable to that of the fold or rope. A common method of preparing these cylinders is to fold lengthwise, in the form of a ribbon, either the third, half, or whole of a leaf of

No. 4 or 6 gold foil; the width of the ribbon determines the length of the cylinders. One end of this ribbon is then held between the thumb and index finger of the left hand, and wound upon a three- or four-sided broach until the cylinder thus formed is of the size desired, when the remaining portion of ribbon is torn off.

The cylinders should be a little longer than the cavity is deep in order to allow for surface condensing. The density of the cylinders depends upon the tightness with which the ribbon is wound upon the broach; by winding it loosely upon the broach soft cylinders are formed, to be placed in contact with the walls of the cavity, while the hard cylinders made by tighter winding are introduced inside of the soft and form the centre of the filling. Different forms as well as sizes of cylinders are necessary in every case, cone-shaped as well as the true cylindrical. The cone-shaped cylinders are useful where there is an under-cutting, and also for completing the introduction of the gold.

These cone-shaped cylinders are formed by winding the ribbon back from the point of the broach, which should taper slightly, in order that the cylinder when completed may be easily detached.

Fig. 392.

Loosely rolled cylinders, prepared ready for use, can be obtained of manufacturers (Fig. 392).

These loose cylinders are useful, applied to the cervical walls of approximal cavities, as a base upon which to build cohesive gold foil.

Also the blocks or mats represented in Fig. 393.

For placing the cylinders in their proper places in the cavity the introducing pliers are necessary, which have smooth points

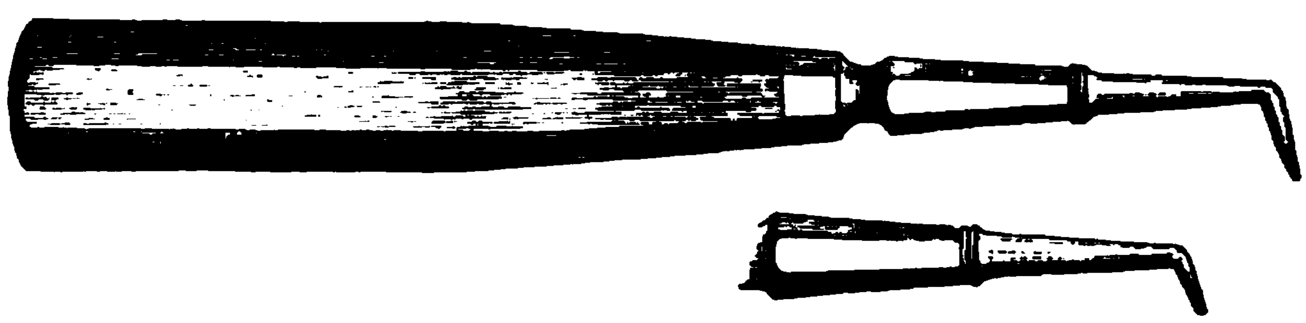
Fig. 393.

bent at such an angle as will permit of their being used when closed, as a condensing point. See Fig. 390.

The cavity being prepared for the gold and properly protected from moisture, one of the soft cylinders is carried into it with the pliers and placed in such a position that one end rests on the bottom and the other protrudes from the orifice. Pressure in the

direction of the wall against which the cylinder rests is then made with the closed points of the pliers, and afterward with a condensing instrument having either a smooth, wedge-shaped point, or, with what is better, a serrated point. When the first cylinder introduced has been well condensed against one of the walls of the cavity, others are introduced and condensed in succession, until these walls are covered by the soft cylinders. The hard cylinders are then disposed round the cavity in the same manner as the soft ones, until it diminishes so much as to render it necessary to form a cavity in the centre of the gold already introduced, by means of a smooth, wedge-shaped instrument, such as is represented in Fig. 394. The cavity formed by this instrument is then filled with a small, dense cylinder, and successive openings are thus made and filled until no more gold can be introduced, when

FIG. 394.



the protruding ends of the cylinders are condensed by pressure applied in the direction of the bottom of the cavity. The surface of the filling is then finished in the manner to be described hereafter. To obtain an extremely dense surface, crystal or sponge gold may be added to the surface of a cylinder filling, before such a surface is condensed, by introducing it into the interstices between the cylinders projecting above the margin of the cavity and then applying mallet force.

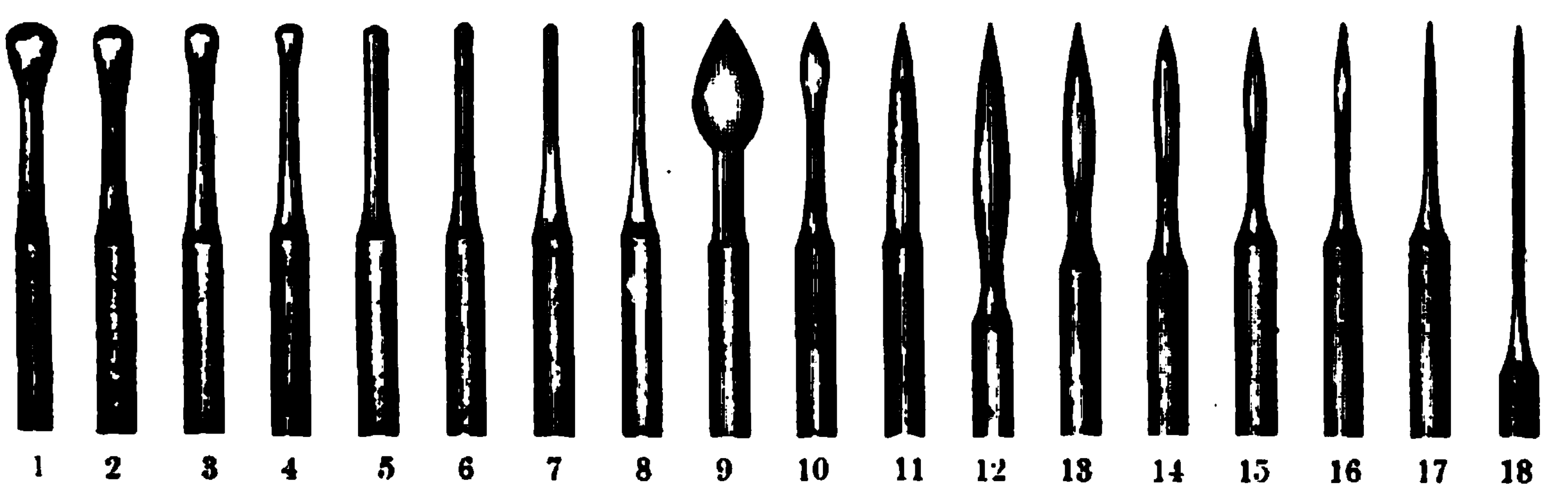
When the cavity is of considerable depth and small in diameter, or the bottom is uneven, pellets of gold may be introduced and condensed upon the bottom until the cavity is about one-third filled. By this method the gold is better adapted to the bottom of the cavity than by placing the ends of the cylinders upon an uneven surface. The surface-condensing of cylinder fillings should be made with small-pointed condensing instruments, and any opening it is possible to make with them be filled with small, dense cylinders.

The Herbst Method.—Dr. Herbst, of Germany, has recently introduced a method of manipulating a quality of soft or non-cohesive

gold, in the form of cylinders, made by Wollrab, of Bremen, to which the name "rotation gold filling" has been given.

Fig. 395 represents the instruments used in the Herbst method, which are smooth, but not polished, and some of the points are quite fine. As these instruments, when made of steel, become coated with gold by its adhesion, they can be cleansed during their use by rubbing their points on a piece of block-tin or upon fine crocus-cloth; it has also been suggested to plate the points with gold. This German gold appears to become cohesive by rubbing it with the instruments, which have points like burnishers and are rotated in the introduction and consolidation of the gold. By slightly annealing the cylinders they can be united, and even hammered, without crumbling in pieces. The cavities into which this form of gold is introduced are prepared in the usual manner, with their edges smooth and slightly rounded off; deep retaining points are unnecessary and but few pits are required. For filling an

FIG. 395.



ordinary cavity in a grinding surface, the quantity of gold first introduced should be large enough to be retained when condensed, without support from an instrument, which is accomplished by packing the cavity loosely, but quite full of the cylinders, when the instruments numbered 2, 3, or 4 (Fig. 395), by a slow rotation, burnish the gold against the walls. A second layer of gold is made to adhere to the surface of the first gold introduced, by the use of the form of instrument represented by numbers 5, 6, 7, or 8, by rotating it quickly until the polished surface of the first gold introduced has been destroyed, when the second layer of gold will adhere to it. The filling of the cavity is continued in this manner until all of the gold necessary is introduced and consolidated.

For filling two superior incisor cavities in opposite approximal surfaces, after being prepared in the usual manner, they are treated as one cavity by introducing the gold into both at the same time

(bringing over), first securing it in the four corners or angles by rotation with the instruments represented by numbers 5, 6, 7, 8, according to the size required, so that a common mass of gold appears. The fine-pointed instrument, No. 18, is then inserted, with regular rotation, into this mass, between the two teeth, until it is separated, when thin files or disks and tape are employed to finish the surfaces of each filling.

For filling two similar cavities in the approximal surfaces of bicuspids and molars a matrix is used, which is secured in place between the teeth with shellac, one cavity being first filled by commencing the introduction of the gold against the cervical wall or border, and condensing against the matrix at that point, and then toward the centre of the crown. The first cavity being filled, the shellac is removed and the remaining cavity filled in the same manner. The rotation and pressure of the instruments appear to produce sufficient heat to render the gold cohesive, and it is claimed that a filling by this method and with this quantity of gold can be inserted very quickly, and that it is impermeable to all fluids.

Pellets.—Another form in which non-cohesive gold foil is used is that of pellets, which are formed by lightly rolling a portion of a sheet between the thumb and fingers. They are made of different sizes, and when placed in a cavity are welded together by means of pointed or serrated instruments. It is necessary that the first pellets introduced should be securely anchored, in order that the successive ones may be built upon them ; these last should be small enough to allow the welding instrument to pass through them to the gold beneath.

COHESIVE GOLD FOIL.

Cohesive gold foil is well adapted for all shallow cavities and for restoring lost portions of the crowns of teeth. While non-cohesive gold is retained by the general form of the cavity, cohesive gold is anchored by means of retaining points or pits, on the principle of welding one piece or fold to another until the required quantity is introduced. The number of retaining pits will depend upon the form of cavity to be filled, varying from three to six. The depth of these retaining points will also depend upon the strength of the walls of the cavity, as will also, in a great measure, their diameter: as a general rule, a greater number of small pits if the wall is weak, and a few large pits where the wall is strong, or where a portion of the filling has to withstand great force. These retaining pits are

made with small, square-edged drills, to a depth corresponding with the diameter of the drill, and in a direction opposite to each other, and in a line with the force to be resisted. Each of these retaining pits is solidly filled with pellets of a suitable size, the pieces of gold being conveyed to the cavity by means of the introducing pliers, and thoroughly condensed by mallet force. The retaining pits being filled, the gold is built over from one to the other, until the surface upon which they are located is covered, which secures a base for the entire filling. Larger pellets are then built upon this base, care being taken to adapt the gold perfectly to the walls of the cavity by gradually building it somewhat higher against the walls than in the centre. The operation is continued in this manner until the edge of the cavity is reached, when the gold is built up in the centre and above and over the margins, to permit of its being so cut away as to conform to the original contour of the surface which it is to restore.

The cutting away of the surplus gold is accomplished by means of suitable plug-finishing files, or plug-finishing burrs, corundum disks or points, Hindostan or Arkansas stone points, etc., after which smoothing process a high polish is given to the entire surface.

In manipulating with cohesive foil, a preliminary step in the operation is to attend to the quality of the gold. It must possess sufficient adhesiveness to cohere under moderate pressure; and as this property deteriorates on the exposure of the foil to the atmosphere, it is often necessary to restore it by the application of heat, as the welding principle, and not mechanical force, is relied upon. To accomplish this, the gold, either in the sheet, ribbon, or pellet form, is subjected to the flame of an alcohol lamp until it becomes a bright red.

Fig. 396 represents a gold-foil annealing lamp. A wire-gauze frame is very convenient for re-annealing the entire sheet, and a mica plate or platinum pan for the pieces or pellets. Many prefer to pass the roll and pellets directly through the flame at the moment they are being carried to the cavity with the introducing pliers. Another method is to boil the gold for a few minutes in a solution composed of forty drops of sulphuric acid and two gills of rain-water. This diluted acid removes all extraneous matter from the surface of the gold, which soon dries, and is found to be very cohesive.

There are a number of methods by which this form of gold foil is prepared for introduction into the cavity. One consists in tearing fragments from a sheet which has previously been annealed and

condensing a single thickness at a time with a fine serrated point. Another method consists in lightly rolling up the whole or part of a sheet in the form of a rope and cutting this up into pellets of different sizes. In forming the pellets, the sheet should be very lightly rolled up between the thumb and fingers, or, what is better, lightly folded by means of a foil folder and chamois skin. It may also be

FIG 396.

folded within the leaves of the book containing it, into two, three, four, or more ribbons, according to the size of the cavity to be filled, and then cut with the scissors.

Fig. 397 represents the foil clippers for cutting ropes of gold into small pieces or pellets without condensing and hardening the edges. Shears and scissors, however sharp, will condense and harden the gold, the edges of which should be left soft and free.

Some, instead of forming pellets, prefer to introduce this quality of gold in a long rope, or, better still, a ribbon containing from one-tenth to one-half sheet of No. 4 foil, which is annealed by holding it in the centre with the pliers and rapidly passing it through the flame. When the gold is ready to introduce and the cavity is carefully dried and protected against moisture—absolute dryness being very essential in the use of all the cohesive forms of gold—the first

pellet, or the end of the rope or ribbon, when this form is used, is carried from the flame to a retaining point in the cavity, where it is securely anchored by being thoroughly consolidated by means of

FIG. 397.

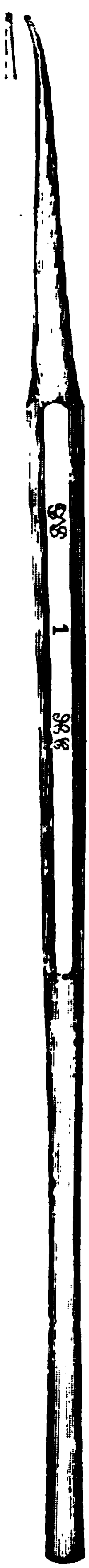
instruments having fine serrated points. As soon as the retaining points are solidly filled, the gold is built up from these over the bottom and sides of the cavity, care being taken to condense it well

against the walls as it approaches the orifice. Every pellet or fold must be consolidated as it is introduced, and the gold built up higher against the *walls* of the cavity than in the centre, until the orifice is reached, when the depression left in the centre can be filled up. Very lightly rolled or folded gold should be applied to the walls of the cavity, else it may clog, and cannot be consolidated to such a degree as is necessary to give solidity to the filling. It is beyond question that to the introduction of the rubber dam is due the splendid achievements with cohesive gold of the present time, as it is absolutely necessary that such gold, during its manipulation, should be kept perfectly dry. The rubber dam has, therefore, become an indispensable aid in all manipulations with gold as a filling material. Should moisture interfere with the introduction of gold in filling a tooth, it is far preferable to remove all that has been introduced and commence anew, than to depend upon any attempt to dry the surface by means of heated air from the hot-air syringe.

Figs. 385, 387, and 388 (pages 542 and 543) represent the forms of instruments for introducing and consolidating cohesive gold foil.

Heavy Foil.—A number of years ago attention was directed by Dr. Robert Arthur to the use of the heavy numbers of gold foil for filling teeth; and later the interest in this form of gold revived to such a degree that very many advoçated its claims.

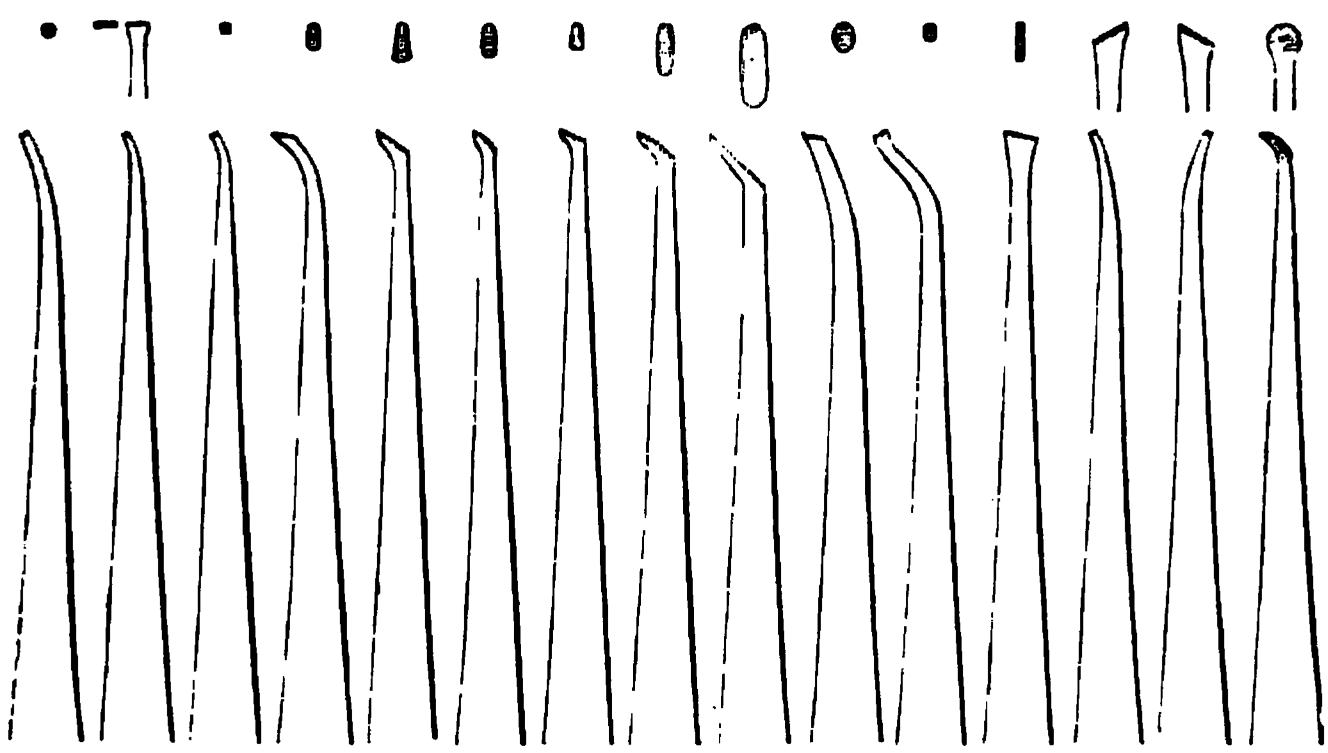
Nos. 15, 20, 30, 60, 120, and even higher numbers have been used. Nos. 15 and 20 can be consolidated by hand force, if such is desired, while the heavier numbers require mallet force. The method of manipulating this foil is to cut it—without allowing it to come in contact with the fingers—into pieces varying from one-fourth to three-fourths of an inch square, or into strips of a proper width and length to suit the cavity to be filled. The gold is then annealed by heating each piece or strip, held by the pliers in the flame of an alcohol lamp, to a red heat. For filling the front teeth the strip is preferable, condensing each layer across the entire surface of the cavity and folding the strip upon itself. Retaining points are solidly filled and the gold built from one to the other, presenting as uniform a surface as possible, and not allowing the foil to become crumpled or folded irregularly upon itself. For filling the posterior teeth the small pieces are preferable, introduced, like the strip, with the pliers, and each one thoroughly consolidated. The gold should be carefully condensed at and over the margins of the cavity, layer by layer.



The manufacture of these heavy foils by rolling instead of beating is said to render them softer and more adhesive; but, in the editor's opinion, this form of gold offers no advantages over the lighter numbers, such as No. 4. On the contrary, it is decidedly more difficult of manipulation and far less easily adapted to the walls of the cavity. Some have found it useful for finishing out the surfaces of large fillings.

Fig. 398 represents a set of Dr. C. R. Butler's instruments for manipulating the heavy foils with mallet force.

FIG. 398.



CRYSTAL OR SPONGE GOLD.

In the use of crystal or sponge gold a different method of procedure is required from that employed with foil.

The chief difference between the instruments employed for introducing and consolidating crystal gold in the cavity of a tooth and those used for gold foil, consists mainly in having the working extremity blunt, varying in diameter from a line to almost a mere point, with shallow serrations upon the surface.

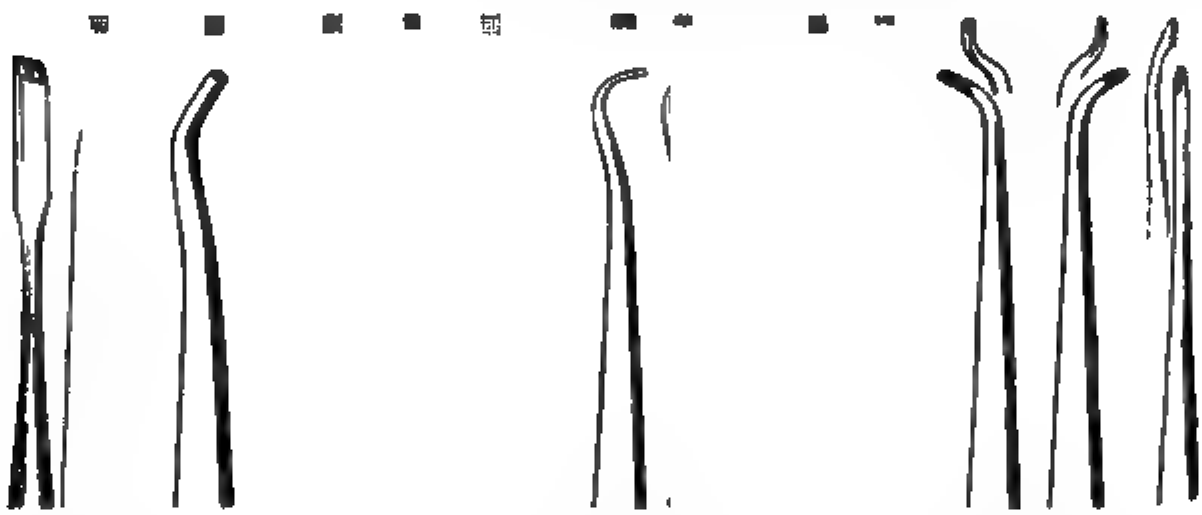
Fig. 399 represents a set of instruments well adapted for the manipulation of crystal gold.

In filling teeth with crystal gold the cavity is prepared in the same manner as when leaf gold is employed. This done, the gold is cut, or rather torn, from the block with the point of an instrument, into small pieces, varying in size according to the dimensions of the cavity and the particular stage of the operation in which it is to be used. It being important that the crystals or particles composing

the mass should be as little separated or displaced as possible before the piece is carried to its place in the tooth, this form of gold should be used in pellets as large as can be introduced into the cavity without crumbling. The gold being divided into pieces of the proper size, the cavity is washed, and then wiped dry with prepared cotton, or flax and bibulous paper; a piece of gold, as large as the orifice of the cavity will receive, is taken up with suitable pliers or one of the sharp-pointed instruments, as may be most convenient.

The spongy mass readily adheres to the serrated surface of the working extremity when pressed gently upon it, and with this it may, in most cases, be carried to the bottom of the cavity. Every part must now be thoroughly consolidated, first with a large, and next with a smaller, and lastly with a very delicately-pointed instrument, so bent that it may be readily applied to all the depressions and inequalities

FIG. 399.



of the walls and floor of the cavity; for unless the gold is made absolutely solid in these places, as well as throughout all the parts of the filling, the success of the operation will be more or less uncertain. Thus, piece after piece is applied, consolidating each one as the operation progresses, until the gold protrudes sufficiently from the orifice of the cavity to admit of a good finish, leaving the surface flush with that of the tooth.

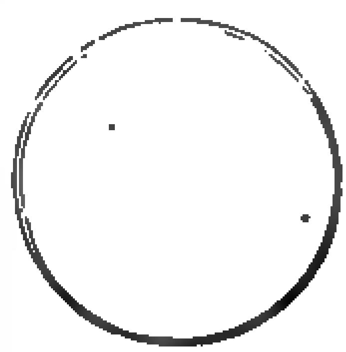
If, during any part of the operation, the smaller-pointed instruments can be forced between the gold and the walls of the cavity, such opening or openings should be filled with smaller masses of the material before another large piece is introduced. This precaution ought never to be neglected; for should any soft places exist after the completion of the operation, the filling will be apt to absorb moisture, and ultimately to crumble and come out. It is also indispensably necessary that the gold, during its introduction into the tooth, be kept absolutely free from moisture, as this destroys the cohesive or welding property of the crystals.

The gold having been introduced and consolidated as directed, the exposed surface is scraped or filed down to a level with the orifice of the cavity, then made smooth by rubbing it with Arkansas stone or with finely-powdered pumice, and burnished or polished with crocus, in the manner as described when gold foil is used.

In finishing a filling made with these preparations of gold the operator should see that there are no thin, overlapping portions upon the teeth outside of the orifice of the cavity. They are liable, in biting hard substances or in ordinary mastication, to be broken off, leaving a depression for the lodgment of extraneous matter and clammy secretions. Sooner or later this will give rise to a softening of the dentine thus exposed, which, if it does not cause the filling to loosen, will ultimately render its removal and replacement necessary. In short, the precautions necessary to be observed in making a filling with gold foil are equally necessary when the operation is made with either of the preparations now under consideration.

Mallet Force in Consolidating Gold.—A number of years ago Dr. W. H. Atkinson introduced a method of consolidating gold by means of mallet force, which has now become a favorite one with many of the best operators in the profession. He claimed for this method the following advantages over hand pressure: A more perfect condensation of the gold and a more thorough welding than can be made by hand pressure; that the gold will be anchored in its position with much more facility; that the instrument always acts under the mallet upon the designed point, does not slip from its position, and, consequently, there is no liability of abrading or wounding the soft parts; that mallet force is not more unpleasant to the patient than the ordinary method of condensing, and that it is far less fatiguing than hand pressure in protracted operations.

FIG. 400.



That mallet force is an effective method of condensing the cohesive forms of gold, there can be no question.

Mallets of almost every description have been used, such as wood, lead, tin, copper, brass, steel, ivory, and vulcanized rubber.

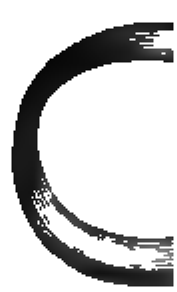
The steel mallet, however, is considered by many to produce the best results, while the lead mallet gives a dead blow and may be more agreeable to the patient.

Heavy lead and tin mallets, weighing from four and a half to six

FIG. 403.

FIG. 404.

FIG. 401.



and a half and even eight ounces, are preferred by many of the advocates of the hand mallet.

In using the hand mallet, which is represented in Fig. 400, the aid of an assistant is necessary, who taps the end of the plugger squarely with sharp, springing strokes, while the principal operator directs its condensing point over the gold as it is introduced into the cavity.

With instruments called automatic mallet pluggers—Fig. 401 represents Snow and Lewis's, Fig. 402 Salmon's, Fig. 403 Taylor's—the aid of an assistant is unnecessary.

All of these forms operate by the action of a spiral spring, and some of them have a back action. Taylor's is the latest form, and in size and action, like the others, is a valuable instrument.

Automatic pluggers for use with the dental engine are also employed for the condensation of gold in filling teeth.

Fig. 404 represents the invention of the late Dr. T. L. Buckingham, which was one of the first of these appliances brought into notice, and which has given satisfaction.

The force of the blow is entirely under control, being determined by the set-screw A, which, if turned to the right, increases the force, and if turned to the left lessens it. The force can also be kept constantly under control by the collar B on the hand-piece. By an almost automatic or instinctive movement of the thumb of the operator the collar is moved up or down, according to the force desired in the blow.

In the same manner the blow can be suspended altogether, at any instant, without interfering with the rhythmical movement of the foot propelling the engine, as when picking up a pellet of gold, or when it is desirable, for any reason, to use the instrument temporarily as a hand plugger.

The force and effect of the blow may also be accurately regulated by the distance at which the point is held from the filling, being heavier according to its proximity to the surface to be condensed. Thus, where very delicate and careful manipulation is necessary, as at the edges of a cavity in a frail tooth, the operator may determine the precise force by the distance at which the point is held.

The bit-holder has a small spiral spring at its inner end, which, after each blow, draws it back instantly to receive the next blow of the plunger. When run at moderate speed this plugger will give about 1800 blows per minute.

Fig. 405 represents an engine mallet invented by Dr. W. C. Bonwill, having his hand-piece attached. This engine mallet gives a very satisfactory blow, and requires but little foot power, and can be worked by either foot and on either side of the chair.

Figs. 406 and 407 represent Holmes's Engine Plugger, and also a

right-angle plugger for the dental engine, which are neat and effective devices and of small size. The force of the blow is regulated by pressure on the point, and pushing forward the button suspends the blow.

Fig. 405.

Figs. 408 and 409 represent acute and obtuse angle engine pluggers for use upon surfaces where the direct action plugger cannot be readily used, such as posterior approximal surfaces.

Fig. 406.

Fig. 407

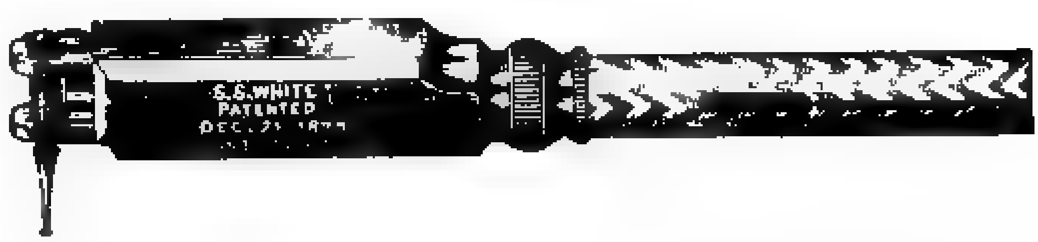


Fig. 410 represents the electro-magnetic mallet invented by Dr. W. G. A. Bonwill, which is used by many of the most skillful operators. Some of its principal advantages are—

First. The blow is delivered upon the packing instrument, just at the point where its force is greatest, as the attraction of the magnets

Fig. 408.

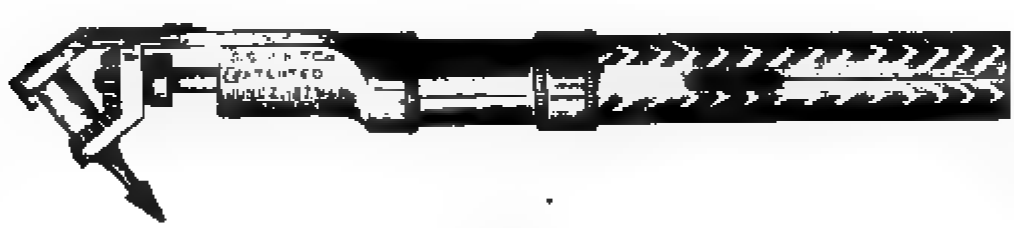
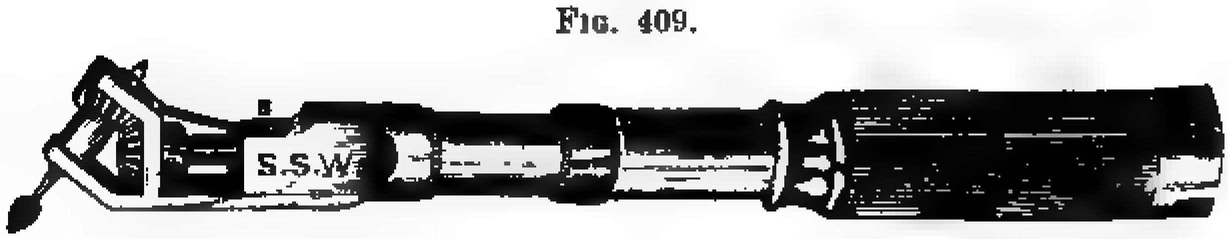


Fig. 409.



constantly increases as the mallet approaches them until the circuit is broken.

FIG. 410.

Second. The force of the blow can at

FIG. 412.

FIG. 413.

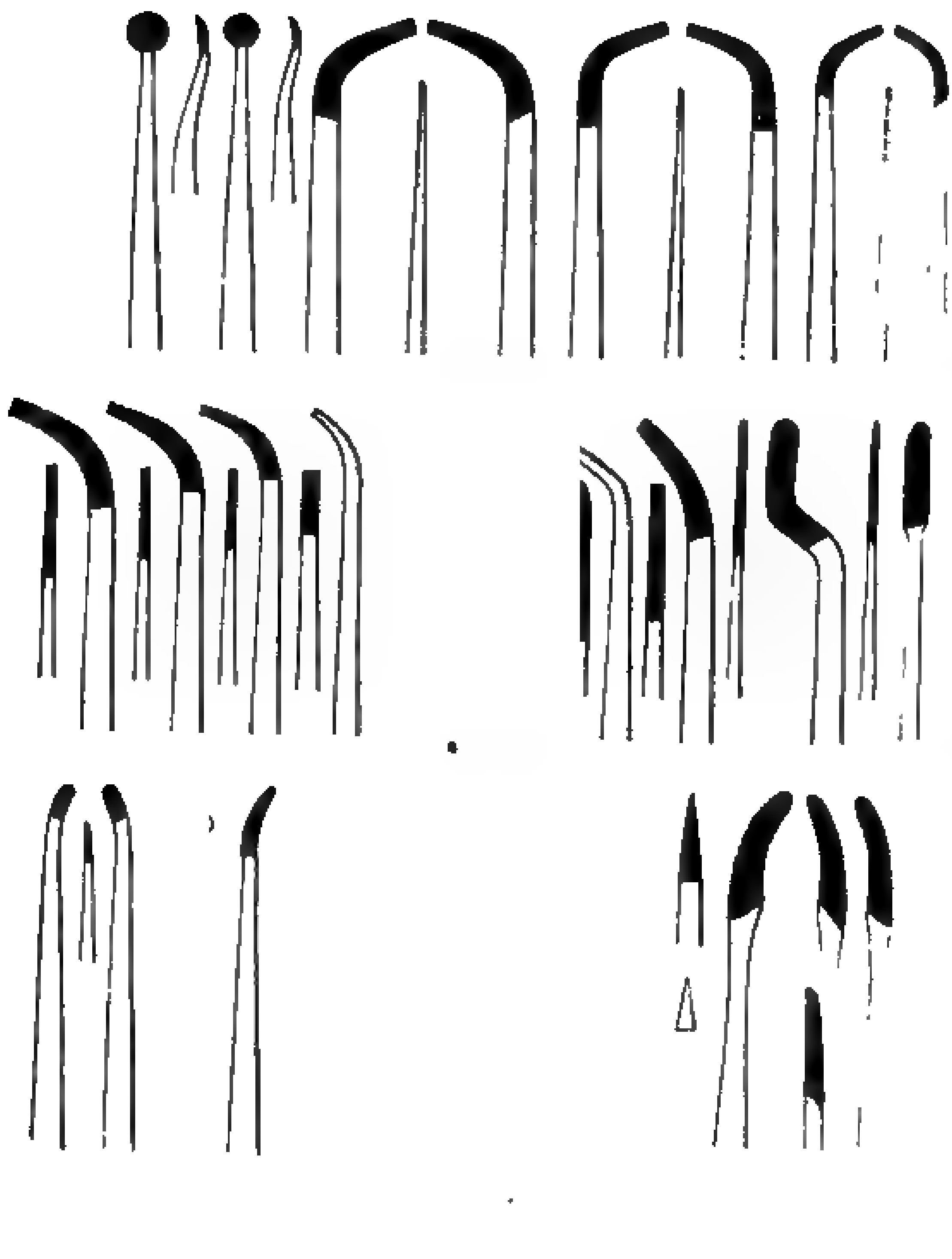


Fig. 414.

Fig. 412 represents a set of instruments devised by the late Dr. Marshall H. Webb, for use with the electro-magnetic mallet.

Finishing the Surface of the Filling.—After having thoroughly consolidated the surface of the filling, finishing files, such as are represented in Fig. 413, are used, to remove the protruding portions of gold, and to form a smooth, uniform surface, free from the slightest indentations which may afford lodgment to extraneous matter. This is a point never to be lost sight of; for, however excellent the filling may be in other respects, if the surface is not smooth, uniform, and flush with the orifice of the cavity, the object intended to be accomplished by it will be partially, if not wholly, defeated.

It is better, however, to cut off but a portion of the protruding gold at first, and then to burnish, condense, and to cut a second time, with a fine file or burr or an emery strip, all it is necessary to remove. After each filing, and before applying the burnisher, the surface should be cleansed of all loose pieces of gold. After a second burnishing, the Arkansas, Hindostan, or Scotch stone, or finely-powdered pumice, may be applied to the surface, to remove all the file scratches and other asperities. For a filling in the approximal surface of a tooth the stone may be shaped like a pinion file; it should be frequently dipped in water, and when its pores become filled with gold the surface may be ground off by rubbing it on a corundum slab. If the filling is finished with pumice, it may be applied with floss silk or tape moistened with water, by drawing it backward and forward across the surface of the filling.

Fig. 414 represents Cazier's Plug-finishing Files, for finishing contour compound gold operations in the approximal surfaces of bicuspids and molars, and they may also be used for the same purpose in operations on the centrals and laterals. With them the gold can be so finished as to

restore the natural contour, thereby preventing the surfaces of the teeth from assuming an unnatural contact.

Fig. 415 represents different forms of plug-finishing burrs for use with the dental engine.

Fig. 415.

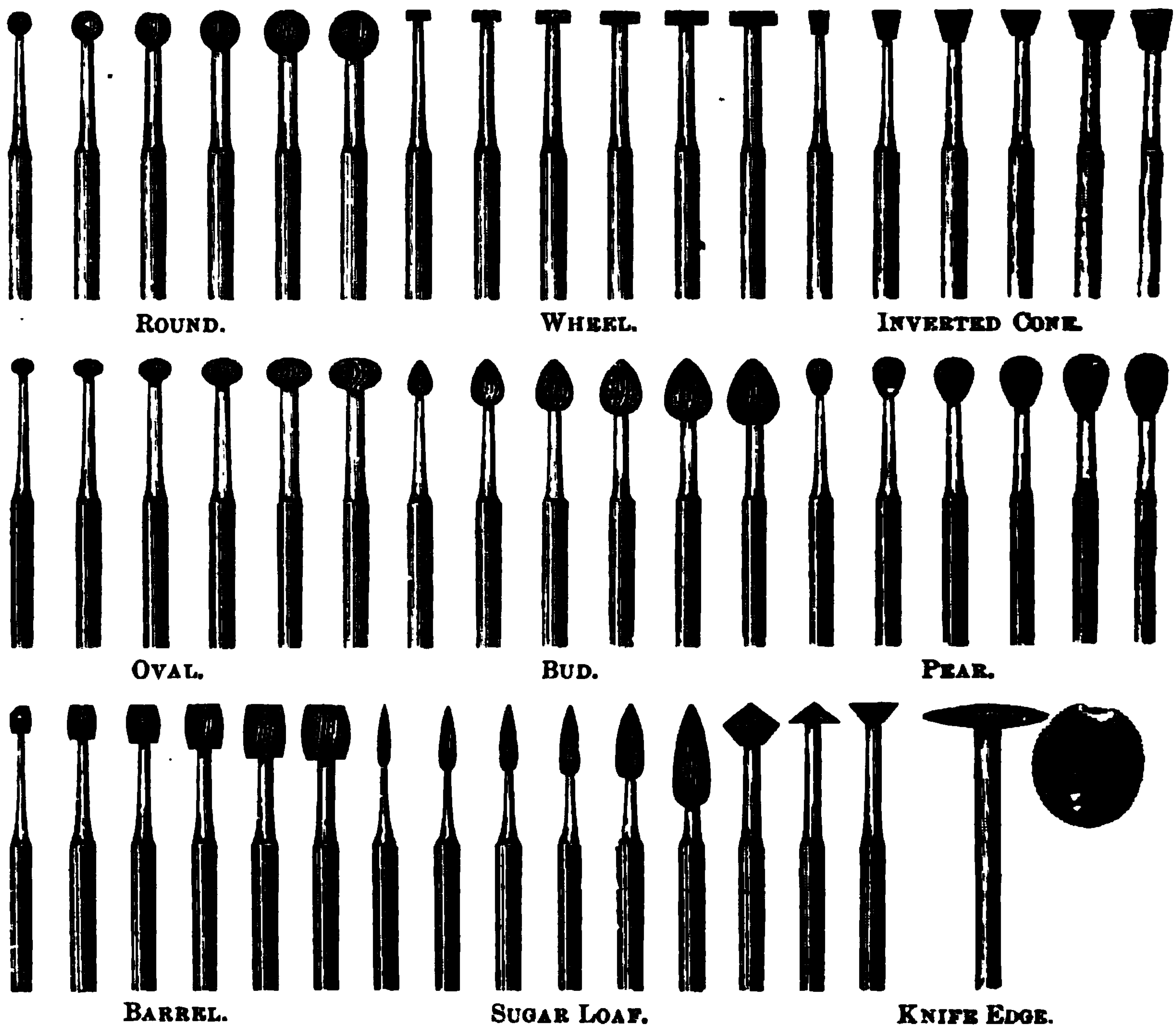


Fig. 416 represents an excellent file-carrier, contrived by Dr. Forbes, for files for finishing fillings on the approximal surfaces of the front teeth, and Fig. 417 a tape-carrier.

Fig. 416.

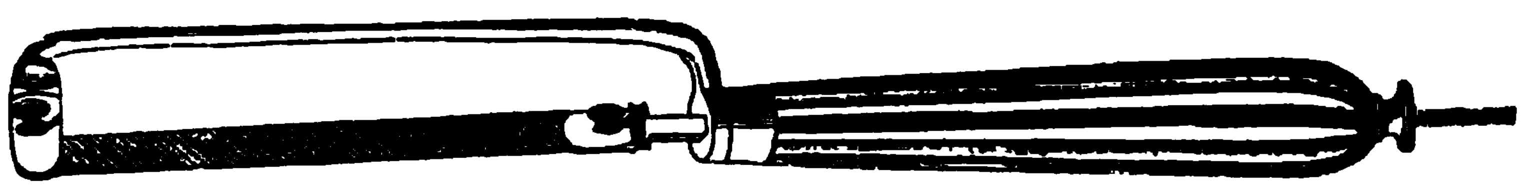


Fig. 417.

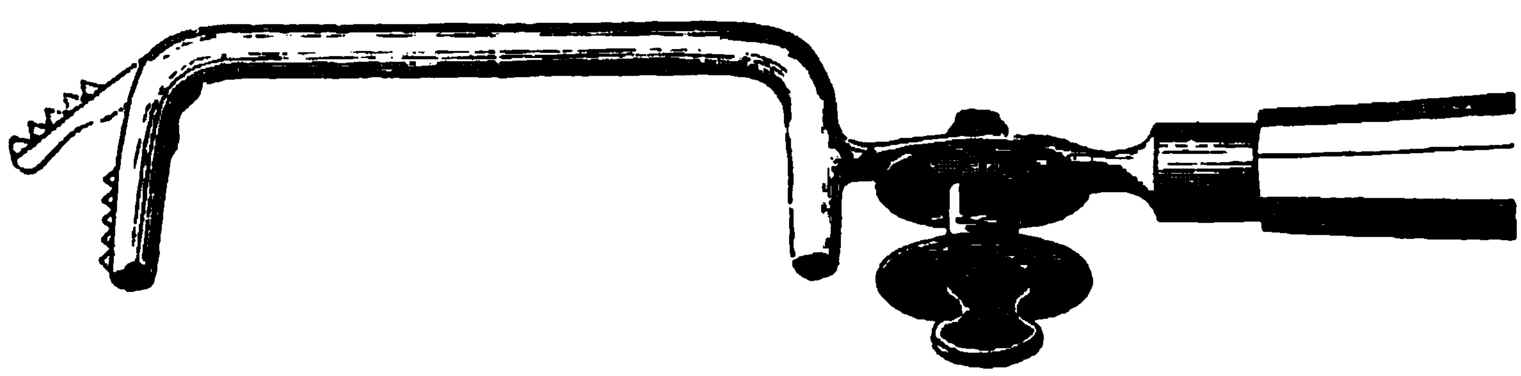
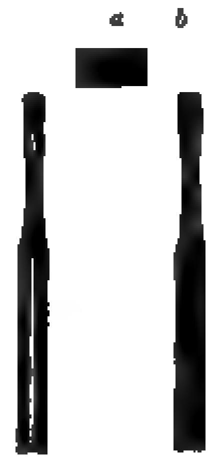


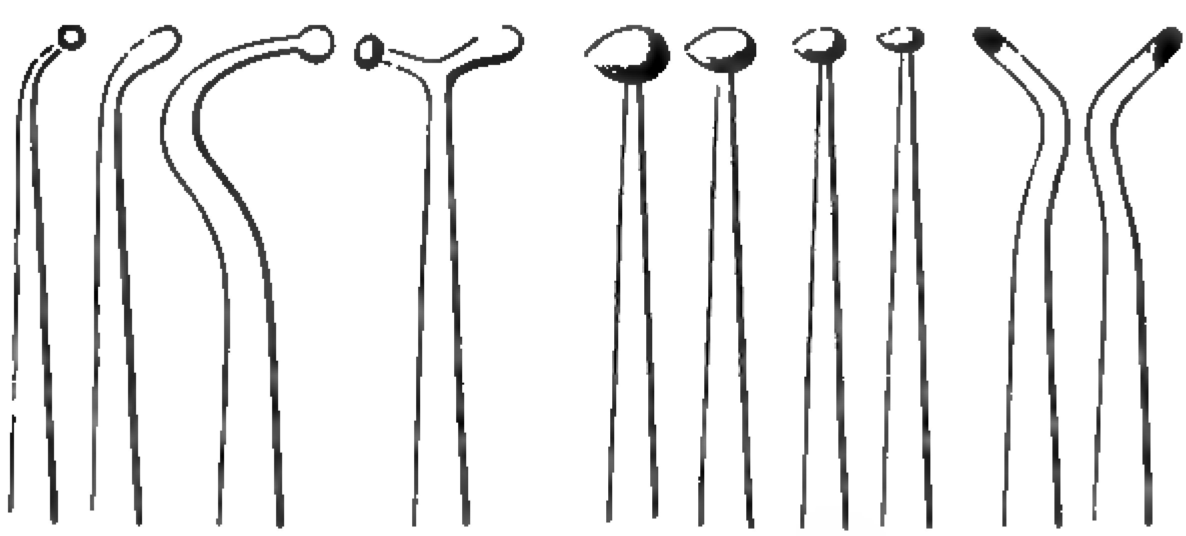
Fig. 418 represents a small split tape arbor for carrying a short piece of polishing tape (Fig. 418 *a*), which by the turning of the bit in the hand-piece is rolled on to the arbor and becomes a small polishing point that will reach fissures and depressions between cusps to finish fillings or gold contour work in a quick and superior manner. Fig. 418 *b* shows the small size of the polishing point thus obtained, but by rolling on a longer piece of tape a correspondingly larger point will be made.

Fig. 418.



If the filling is in the grinding, buccal, or palatine surface of a molar or bicuspid, a long piece of stone, having a small, triangular, and slightly oval point, may be used; if powdered pumice-stone be employed, it may be used on the point of a similarly shaped piece of soft wood, previously softened in water. After all the asperities have been cut down, the surface should be washed until every particle of grit is removed.

Fig. 419.



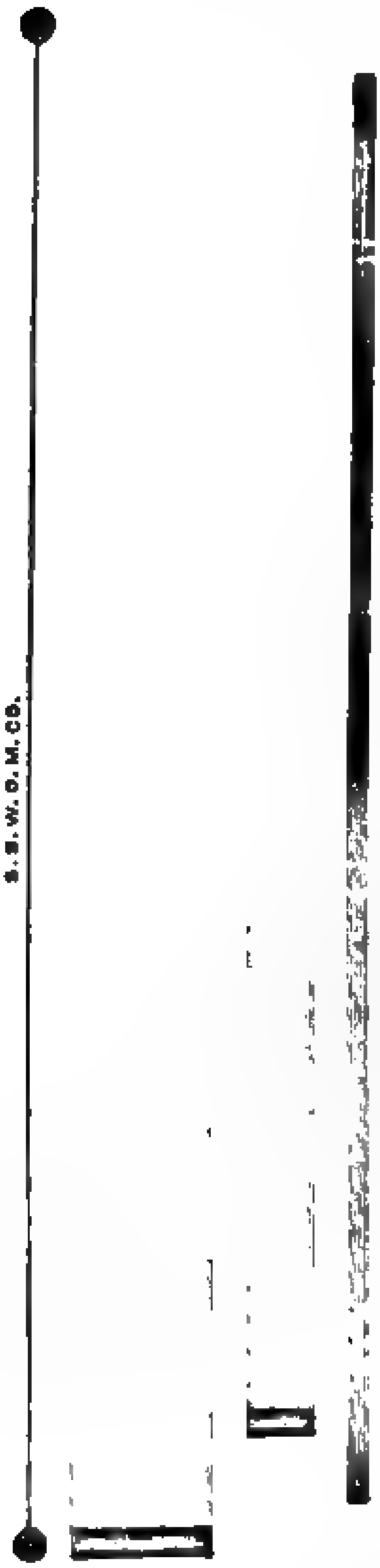
This done it may be polished with a suitable burnisher, dipped from time to time in a solution of pure Castile soap, until the filling is rendered as brilliant as a mirror. Fig. 419 represents various forms of burnishers.

Fig. 420.

Fig. 420 represents a set of burnishers for use with the dental engine.

For polishing fillings on proximate surfaces and between teeth, Dr. Brown's metal tape, used with wet polishing powder, will be found very effective, especially in spaces too small for the entrance of silk (Fig. 421).

Fig. 421.



Various instruments are used in the process of finishing the surface of metallic fillings, such as coarse and fine burrs, corundum points, wood points, emery strips, sand-paper disks, all rotated by the dental engine.

Having proceeded thus far, the surface may be again washed and the operation completed by rubbing it from three to six minutes with dry floss silk. Rouge or rotten stone applied to the surface on tape, or finely-powdered silex or pumice-stone on a piece of orange wood after it is prepared by the method just described, will remove the bright metallic lustre—when this is objectionable on account of the exposure of the filling—and leave a fine finish. Holly strips in the form of thin shavings answer admirably for applying levigated pumice, rouge, etc., in the polishing process.

Non-Conductors.—When the caries has penetrated nearly to the pulp cavity, the presence of a gold or any other metallic filling is sometimes productive of considerable pain and irritation, especially when hot or cold fluids are taken into the mouth or during the inspiration of cold air. In some cases inflammation and suppuration of the lining membrane and pulp supervene. To prevent these disagreeable results a variety of means have been proposed. Dr. Solyman Brown recommended placing asbestos, this being a non-conductor of caloric, on the bottom of the cavity previously to the introduction of the gold. The author prefers a thin layer of *gutta-percha*, which may be used in the form of a thick solution prepared with chloroform, or a layer of thin gutta-percha cloth may be placed at once in the bottom of the cavity. When the solution is used a drop may be placed in the

cavity and a sufficient time allowed for the chloroform to evaporate before introducing the filling. A thin layer of "Hill's stopping," of which gutta-percha forms the principal ingredient, may be used with equal advantage. Oxychlorides and oxyphosphates of zinc have also been used for the same purpose, but the latter are less irritating than the former and neither possess any advantages over gutta-percha.

The time required by an expert operator to fill a tooth well may be said to vary from thirty minutes to two hours and a half, according to the size, shape, and situation of the cavity, and in some cases a much longer time will be required. The author has found it necessary in filling some cavities, especially when the restoration of a large portion of the crown was called for, to bestow as many as six hours' constant labor upon the operation. Less time and skill are usually required to fill a cavity in the grinding than in the approximal surface of a tooth; but the operation in either place, to be beneficial to the patient, must be performed in the most thorough manner. The dentist who does not feel the importance of making all his operations as perfect as possible should never be intrusted with the management of these important organs. Want of attention to two points in the consolidation of a filling often causes the ultimate failure of operations in all other respects well performed. First, by not making sufficient *lateral* compression whilst introducing the gold the surface is apt to be more solid than the interior. Consequently the filling may drop out for want of a firm contact against the sides; or, if retained, it is apt on grinding surfaces to be pressed inward, leaving a space around the orifice for the penetration of fluids. Second, want of care in condensing around the edges of the filling will, by the crumbling away or scaling off of portions of the gold, expose the edges of the cavity to decay.

In every part of the operation the dentist should so guard his instruments as to prevent them from slipping, which he will usually be better able to do by standing a little to the right and behind his patient than in any other position. In filling the lower teeth he should stand several inches higher than while filling the upper, and for this purpose he should have a stool or movable platform on which to stand. When it can be done, he should grasp the tooth with the thumb and forefinger of his left hand, not only to prevent it from being moved by the pressure he applies, but also to catch the point of the instrument in case it should slip; if he is always careful to press in a direction toward the orifice of the cavity this need not happen; nevertheless, he should always take the precaution to guard against possible accident. When he cannot shield

the mouth with the thumb and finger of his left hand, he should let the thumb or one of the fingers of his right rest either upon the tooth he is operating on or upon some other.

For the special application and modification of these general directions the reader is referred to the filling of individual cavities in teeth.

FILLING INDIVIDUAL CAVITIES IN TEETH.

To describe the method of filling each individual cavity in every locality in which a tooth is liable to be attacked by caries would be unnecessarily tedious. But as this is one of the most important and, at the same time, one of the most difficult operations in dental surgery, it may be well to enter a little more into detail upon the subject than we have as yet done. In doing this the writer will confine himself, for the most part, to the manner of filling a cavity in each of the following localities, which are the parts of teeth most liable to caries.

First. In the approximal and labial surfaces of the superior incisors and cuspids and the palatine surfaces of the incisors; the anterior surfaces of the cuspids and the posterior surfaces of cuspids and incisors being rarely attacked by caries.

Second. In the grinding, approximal, buccal and palatine surfaces of the molars and bicuspids of the upper jaw.

Third. In the approximal surfaces of the inferior incisors and cuspids.

Fourth. In the grinding, approximal and buccal surfaces of the molars and bicuspids of the lower jaw.

Other parts of the teeth sometimes become the seat of caries, but the foregoing are the localities most liable to be attacked by the disease.

FILLING THE SUPERIOR INCISORS AND CUSPIDS.

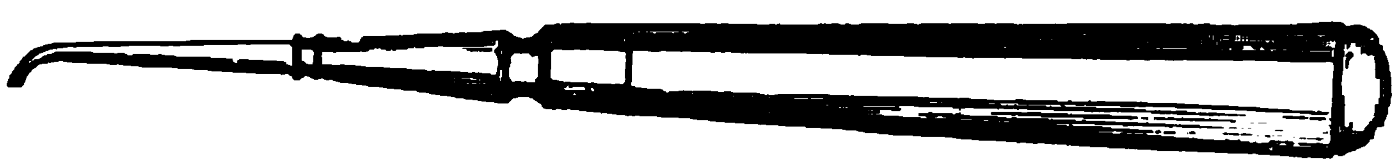
I. *With Non-cohesive Gold Foil.*—In describing the manner of introducing a filling in one of the first-named teeth, we shall commence with the right approximal surface of the left central incisor. The directions we propose giving for the performance of the operation here will be applicable, with a few exceptions, to the same surface on all the upper incisors. As a general rule, the gold should be introduced from behind the teeth forward and upward, and for the following reasons: 1. When the aperture between the teeth has been formed with a file it should, when the circumstances of the case will permit, and for reasons stated in another place, be made wider behind than before; consequently, the diseased part can be most easily approached from this direction. 2. The gold, in the majority

of cases, can be more conveniently introduced from the palatine side, and the force required for condensing it can be more advantageously applied.

The exceptions to the above rule are when the approximal side of the tooth is turned slightly forward toward the lip, and when the caries is situated nearer the labial than the palatine angle; also, when the teeth, instead of occupying a vertical position in the alveolar border, or projecting slightly, as they usually do, incline backward toward the roof of the mouth. It sometimes happens, too, when they are separated by pressure, that the diseased part can be most conveniently reached from before.

The instrument which the author has found best adapted for the introduction of the gold into a cavity in the right approximal surface of an incisor or cuspid tooth is represented in Fig. 422. The

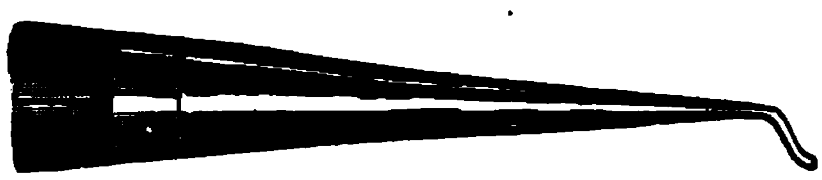
FIG. 422.



width and length, as well as the curvature or angle of the point, should vary according to the size of the cavity and the width of the space between the teeth.

The stem of the instrument, as well as the shank, should be strong enough to sustain any amount of pressure which it may be neces-

FIG. 423.



sary to apply in forcing the folds of gold tightly against each other. The point should be wedge shape and the extremity serrated.

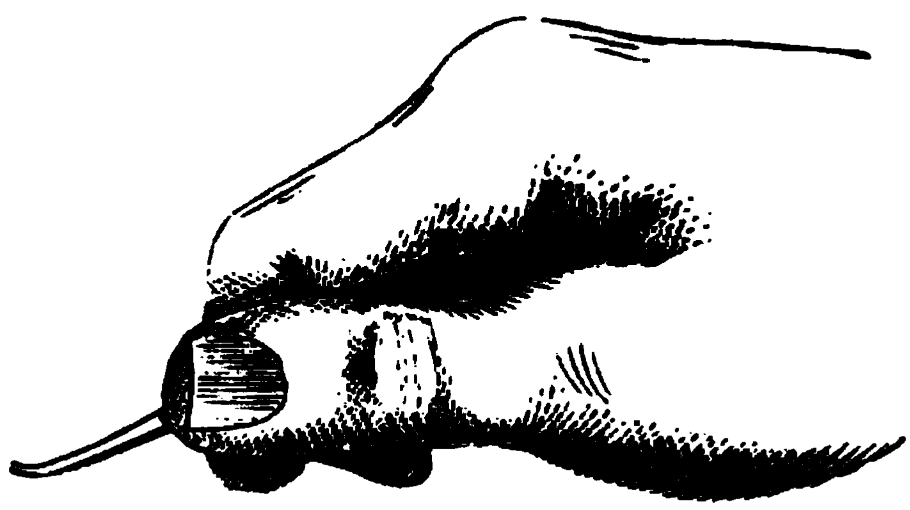
The decay having been removed, the cavity, properly shaped, cleansed, dried, and protected, is ready for the reception of the gold. The patient should be seated in a chair sufficiently high to bring the head on a level with the breast of the operator and resting on the head-piece of the chair, with the face upward. The operator, standing upon the right side, should support the patient's head firmly with his left arm during the operation, while with the forefinger of the same hand the upper lip is held out of the way. The middle finger of the same hand ought to rest on the end of a tooth to the left of the one on which the operation is being performed,

while with the little finger the lower lip may be gently depressed. The roll or strip of gold is first introduced with the foil pliers.

During the introduction of the gold the instrument should be held in the right hand of the operator (Fig. 424), and grasped with sufficient firmness to prevent it from slipping or rotating.

In introducing the gold the first fold should be applied against the upper wall of the cavity, that the pressure may always be exerted in a direction toward the extremity of the root, applying each additional fold as closely to the preceding one as possible. The

FIG. 424.



folds should also, in their introduction, be applied as closely to the labial and palatine walls of the cavity as possible, but always directing the pressure, when these are thin and brittle, in the direction of the axis of the root.

When the lower part of the cavity is very narrow, as is often the case, especially where it extends nearly to the labial angle of the tooth, it is often necessary to change the instrument for one having a smaller point.

To carry a fold of gold to the bottom of a cavity upon the point of the instrument, without breaking or cutting it, requires some tact. The point should never be carried directly toward the bottom; on entering the orifice, it should be inclined toward the wall of the cavity opposite the one against which the folds are first laid. Equally as much tact is required to prevent displacing the gold before a sufficient quantity has been introduced to procure support for it from the surrounding walls, which is an accident particularly apt to occur with young practitioners, when the cavity is superficial and has a large orifice. To prevent this, the folds of gold should be long enough to project some distance from the orifice, that they may receive support from the adjoining tooth, and from the thumb and forefinger of the left hand of the operator, until the operation has reached that stage when sufficient stability shall have been obtained from the walls of the cavity.

There are cases in which an instrument like the one represented in Fig. 425 can be very advantageously employed in the introduction of the gold; but in the majority of cases the instrument represented in Fig. 422 will be found more convenient.

After having filled the cavity so thoroughly that a small wedge-pointed instrument cannot be made to penetrate the gold at any point, the extruding portion of the filling should be consolidated, beginning with the portions overlapping the lower part of the tooth and the edge of the posterior wall. These should be carefully and firmly pressed toward the cavity with an instrument having a flat point, like the one represented in Fig. 426. This done, it may be

FIG. 425.

FIG. 426.

firmly applied to every part of the surface of the filling, continuing the pressure as long as the point of the instrument can be made to indent the gold.

When the space between the teeth is very narrow, an instrument shaped as in Fig. 427 may be used. The operator should be provided with two or three instruments like each of the two last, varying in the size, length, and curvature of their points.

During the process of consolidating the gold, the tooth should be firmly grasped between the thumb and forefinger of the left hand;

FIG. 427.

FIG. 428.

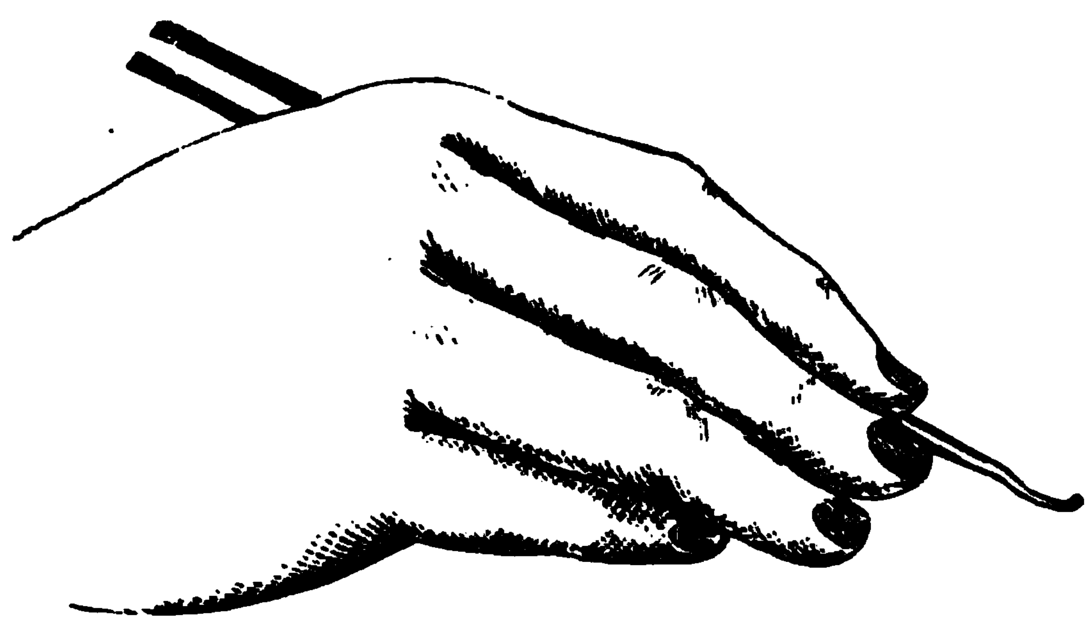
this prevents it from being pressed too forcibly against the opposite side of the socket, while, at the same time, the end of the forefinger, by being placed above the instrument, assists in directing its point and serves to keep it from slipping. When the labial and palatine walls of the cavity are very thin, great care is necessary to prevent fracturing them in introducing and consolidating the gold. The consolidation should be commenced around the edges, and the pressure applied toward the centre of the cavity.

It sometimes happens that the caries extends forward to the labial angle of the tooth, and upward, at the same time, under the edge of the gum. Great difficulty is often felt in thoroughly filling this portion of the cavity, and it cannot always be done from behind the tooth. In this case, after having filled the cavity in the manner as already described, the operator may, standing on the left side of the

patient, and with an instrument having a wedge-shaped point (Fig. 428), make as large an opening as possible in the gold. This done, he may grasp the left lateral incisor or cuspid tooth with the thumb and middle finger of his left hand, elevating the upper lip with the forefinger of the same; then, with the instrument held as in Fig. 429, he may proceed to introduce the gold, filling the upper part of the opening first. After introducing fold after fold, until it is completely and compactly filled, the extruding portion should be consolidated with a similarly-shaped instrument, having a flat, serrated point, this style of point being preferable to the round point for introducing and consolidating non-cohesive gold.

The size of the roll of gold must be varied to suit the size of the cavity, though it should seldom have in it more than a fourth of a

Fig. 429.



leaf of No. 4. If more than this be employed at one time, it will be difficult to apply the folds sufficiently near each other.

The method of filling the right central incisor in the left approximal surface is so very similar to that of filling the left in the right side that it will not be necessary to enter so minutely into detail. In this, as in the other case, the gold, as a general rule, should be introduced from behind the tooth, forward and upward; but if introduced from the front, the operator should still stand on the right side of the patient. The head should have the same elevation and inclination backward, but the face should be turned more toward the operator, to give him a better view of the cavity in the tooth, and to enable him to reach it more readily with the instrument.

The cavity being formed, cleansed, and dried, the operator may proceed to introduce the gold as already directed, with an instrument like the one represented in Fig. 422. In many cases, however, he will require one having a somewhat longer point, and curved at nearly a right angle with the stem. The instrument should be held

somewhat differently in the hand (Fig. 430), and grasped firmly with the thumb and fore and middle finger, so as to prevent it from rotating. The head should be securely confined with the left arm, the upper lip raised with the left thumb, pressing it at the same time firmly against the anterior surface of the tooth. The middle or fore-finger of the same hand may be placed against the gum just inside the tooth, to direct the application of the point of the instrument,

Fig. 430.

prevent the liability of its slipping, and control the free end of the roll of foil. The lower lip may be depressed either with the middle joint of this or with one of the other fingers.

After having placed one end of the gold in the cavity, fold after fold should be introduced until it is compactly filled, except in those cases where the lower part is very small, when a smaller-pointed in-

Fig. 431.

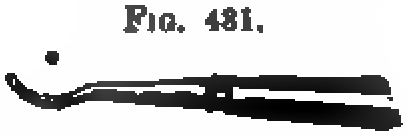


Fig. 432.

strument should be employed for the completion of the operation and, indeed, for the introduction of all the gold, if the cavity is not large, or the aperture between the teeth very narrow.

For consolidating the extruding gold, the instrument represented in Fig. 426 will, in many cases, be all that is required. But the one represented in Fig. 431 can sometimes be used very advantageously; and the one in Fig. 410 will be found a useful condenser for the right as well as the left approximal surface of an incisor or cuspid tooth; and both the last mentioned instruments may often be used to great advantage on the approximal surfaces of other teeth. Some of the instruments employed in filling teeth with adhesive and crystal or sponge gold may also be advantageously employed in consolidating the ordinary gold in the approximal surfaces of the incisors and other teeth.

In completing the operation, it is important that every particle of gold overlapping the orifice, and frequently extending under the free edge of the gum, should be removed before finishing the surface of the filling; but the operator ought, at the same time, to avoid as much as possible wounding the gum and dental periosteum. As the cavity frequently extends a little above the gum, great care is necessary to prevent wounding it; indeed, there are many cases in which it cannot be avoided, unless the point of the gum is pressed up between the teeth by the introduction of a piece of raw cotton, band of rubber or wedge of wood, or Hill's stopping, a day or two before the operation of filling is performed.

In filling an incisor or cuspid tooth on the labial surface the operation is often very simple and easy, but there are many cases in which it is both difficult and tedious. The head of the patient should rest with the face upward, as already described, and sustained in the same way, with the left arm of the operator, while, with the thumb

FIG. 488.

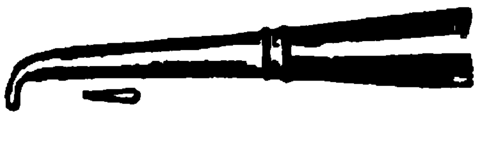
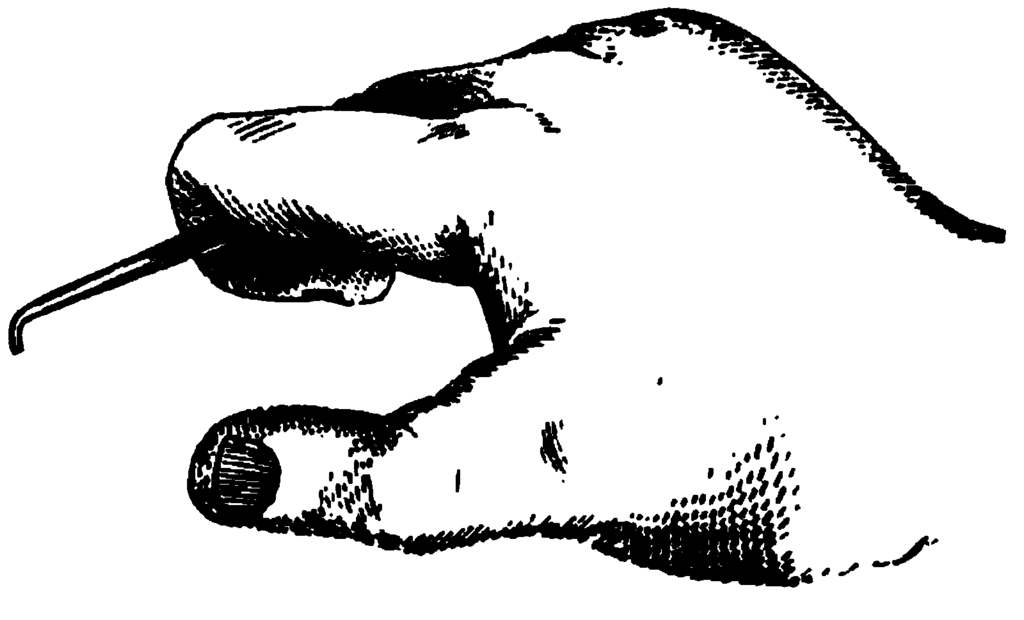


FIG. 484.



of the left hand placed on the gum above the tooth, the upper lip should be elevated.

The forefinger should be pressed firmly against the palatine surface of the tooth and the left side of the chin gently grasped with the other three fingers. Then, with an instrument (Fig. 433) having a wedge-shaped point, grasped with the right hand, as in Fig. 430 or 434, the operator should proceed to introduce the gold, standing at the right side of the patient, with the thumb of the right hand resting on a tooth to the left of the one he is about to fill or against the cheek. He should commence by laying the first fold against the walls of the cavity nearest to him, and thus introduce fold after fold, until it is compactly filled. The extruding portion may be consolidated with a round or square-pointed instrument, or with a sharp-pointed one, as represented in Fig. 435. Great care is necessary to prevent the instrument from slipping and wounding the gums. After having

partially consolidated the gold, the overlapping portion must be firmly pressed toward the centre of the cavity, and the point of the instrument repeatedly applied to every part of the surface of the filling, until it can no longer be made to yield to pressure. This done, the gold may be filed down to the level of the tooth, smoothed with Arkansas stone, and burnished or polished.

When the cavity is shallow and the orifice broad, the gold, as it is introduced, must be held in its place with the thumb of the left hand until a sufficient quantity has been placed in the cavity to obtain for it the necessary support from the surrounding walls. But in overcoming difficulties of this sort, the peculiar circumstances of the case can alone suggest the proper means to be employed by the operator.

The decay sometimes extends entirely across the labial surface of the tooth, leaving after its removal a horizontal groove open at both ends. In this case the walls should be made rough, wider at the bottom than at the opening, and the operation of filling commenced at one end by applying the folds of foil alternately against the upper and lower wall, and consolidating them so thoroughly as to prevent

FIG. 435.

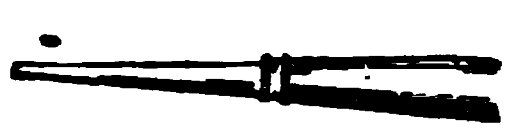


FIG. 436.

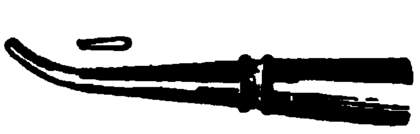
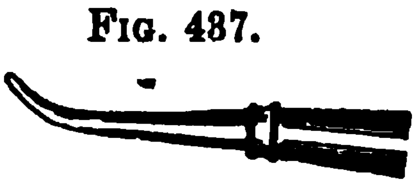


FIG. 437.



the liability of their being displaced during any subsequent part of the operation. Successive folds are introduced in the same manner, each in close contact with the preceding series, until the groove is completely filled, applying the pressure, during the whole of the operation, against the two walls. In condensing the extruding gold, the operator should commence first at one end of the groove, then at the other, and afterward consolidate the whole surface of the filling. In finishing the operation, the same precaution with regard to wounding the gum and dental periosteum should be observed here as recommended for the approximal surface of the tooth.

Although it rarely happens that the palatine surfaces of the upper incisors are attacked by caries, yet the disease does sometimes develop itself there, in the indentations occasionally found a little below the free edge of the gum. The removal of the diseased part, the formation of a cavity, and the introduction of a filling can, in the majority of cases, be more easily accomplished in this than in any other part of an incisor tooth.

The cavity being properly prepared for filling, the head should be placed as before directed, except that the chin may be a little more

elevated, to enable the operator to obtain a more convenient view of the locality of his operation: the thumb of the left hand may be placed on the labial surface of the tooth and the forefinger on the gum immediately above the palatine surface. He should now, with a wedge-pointed instrument, shaped as in Fig. 436, proceed to introduce the gold, applying the first fold against the palatine wall or the palato-approximal angle of the cavity, as may be most convenient. Having filled the cavity, the extruding gold may be condensed with an instrument like the one represented in Fig. 437.

Sometimes straight instruments, and at other times instruments curved at the points more than those represented in Figs. 436 and 437, can be more conveniently employed, depending altogether upon the size of the mouth and the forward or backward deviation of the teeth from a vertical position. This is a matter, therefore, which the judgment of the operator must determine.

II. *With Cohesive Gold Foil.*—For filling cavities in the approximal surfaces of the superior incisors and cuspidati, the most effectual means should be adopted to retain the filling. In some few cases it may not be possible to do more than form small undercuttings at each approximal angle of the cavity, and another similar one at the cutting-edge, which would be sufficient for the retention of a non-cohesive gold filling; but in the majority of cases one of cohesive gold can be so securely anchored that the cervical wall is perfectly protected, and a fracture at any point along the edges of the cavity will not dislodge the filling.

To effect this, retaining-points, made by a small, square-edged drill, are necessary, which can be formed in approximal surface cavities of the incisors and cuspidati, in that portion of the dentine near the labial surface where it unites with the cementum, and in the same position in the palatine surface. These retaining-points can be made from the one-twentieth to the one-sixteenth of an inch in depth, and in addition a small undercutting on the wall next to the cutting-edge. In drilling the retaining-points in the cervical wall near the labial and palatine surfaces, the drill should be directed in a line with the long axis of the root, in order that the cavity made by it is sufficiently distant from the pulp of the tooth. The cavity being properly formed, dried, and protected from all moisture, the gold foil, prepared in the manner before described, is carried into the cavity with the introducing pliers or on the point of an instrument, and packed into the retaining-points until these are solidly filled.

The gold is then compactly built from one of these retaining-

points to the other, and over the floor of the cavity, until a base is formed extending over the whole of the floor.

From this base the gold is then built to the orifice; and during the entire process it is packed a little higher about the walls than in the centre, in order to obtain a more thorough contact. When the gold has reached the orifice, the centre is then built up and the surface condensed and finished as before described.

Crystal gold is preferred by some for filling the retaining points and forming the base covering the floor of the cavity, on account of its retaining its position better than foil. This description of the method of introducing cohesive foil will apply to all cavities wherever situated, and need not be repeated hereafter. For crystal gold the cavity may be formed in the same manner as for cohesive gold foil, although many depend upon under-cuttings instead of retaining points for its retention.

The margins of the cavity to be filled should be uniformly shaped, to permit of the easy introduction of the gold over them when it is carried into the cavity, and the edges should be slightly countersunk, to protect them from fractures and to permit of a more perfect adaptation of the gold to the margins, and also to properly define the margins of the filling in the process of finishing the surface. Such directions will apply to all cavities in teeth during their preparation for filling.

FILLING THE SUPERIOR MOLARS AND BICUSPIDS.

I. *With Non-Cohesive Gold Foil.*—In describing the manner of filling a cavity in each of the principal localities liable to be attacked by caries in the above-mentioned teeth, the writer will begin with the grinding surface of the first molar on the right side. The directions given for filling a cavity here will, with a few exceptions, be applicable to the introduction of a filling in the grinding surface of any of the upper molars or bicuspids.

When the cavity is very deep and its circumference not large, it is difficult, if not impossible, to make a filling sufficiently firm and solid in every part by the introduction of folds of gold long enough to extend from the bottom to the orifice. The operation, therefore, should be divided into two parts; two-thirds of the cavity should be first thoroughly filled with vertical folds, and afterward the remaining third in the same manner.

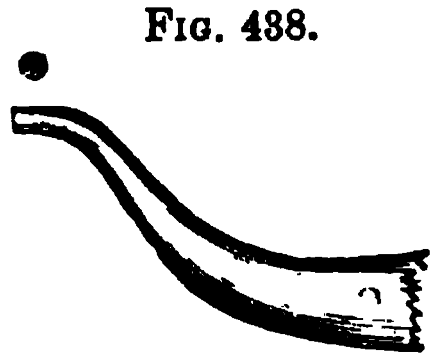
In filling a molar or bicuspid on any of its surfaces the head of the patient should, for the most part, occupy very nearly the same position and have the same elevation as required for an operation on an incisor or cuspid. The cavity being prepared for the filling, and

one end of the roll or ribbon of foil placed in it, the tooth may be grasped with the thumb and forefinger of the left hand of the operator—the former placed on the buccal surface in such a manner as to press back the commissure of the lips, and the latter on the palatine surface; then fold after fold may be introduced and forcibly pressed against the posterior wall until the cavity is filled. For this purpose an instrument may be used like the one represented in Fig. 433 or 436. If the former is used, it is to be held as shown in Fig. 430. The extruding portion should then be condensed with the same instrument as the one used for introducing, and is still more condensed, if necessary, with pluggers similar to Figs. 437 and 438.

As a general rule, filling a cavity in the grinding surface of an upper molar or bicuspid is an exceedingly simple operation, requiring less skill than the introduction of a plug in any other locality in these teeth; but there are cases in which it is rendered very difficult, as, for example, when there are one or more fissures or carious depressions radiating from the main cavity. After the caries has been removed and the fissure enlarged, which was often a very tedious operation before the use of fissure burrs with the dental engine, it requires considerable time and skill to fill these thoroughly. When it is not properly done, as is too often the case, a recurrence of the disease will soon take place, and thus defeat the object for which the operation was performed.

The introduction of a filling in the grinding surface of the second or third molar of a person having a very small mouth is sometimes attended with great difficulty; in some cases it can only be done with an instrument having a point bent nearly at right angles with the stem, like the one represented in Fig. 438; consequently, the power required for introducing and consolidating the gold is applied to great disadvantage. But the instrument represented in this cut is only intended for the first part of the operation of consolidating the metal; for its completion smaller points are required.

FIG. 438.



In filling a cavity in the grinding surface of a first upper molar on the left side of the mouth, the thumb of the left hand may be placed against the left cuspid or first or second bicuspid, as may be most convenient to the operator, while the forefinger is placed behind the point of the instrument and at the same time made to push back the commissure of the lips. To obtain a good view of the cavity in a second or third molar during the operation, the

cheek should be pressed from the tooth with the forefinger of the left hand; but this finger can seldom be carried far enough back on this side of the mouth to be placed behind the point of the instrument. During the introduction of gold the instrument should be grasped as in Fig. 430, or, better still, as in Fig. 434.

In filling a cavity in the anterior approximal surface of a right superior molar or bicuspid, the operation may be commenced by placing the gold against the palatine wall and ending at the buccal. But before the process of condensing is commenced every portion of the surface ought to be thoroughly tested with a wedge-pointed instrument, and wherever the point can be forced into the gold the cavity thus formed should be filled. The instrument employed for the introduction of the gold may be like the one represented in Fig. 433, but having a rather longer point and grasped as in Fig. 430. For condensing the extruding portions, either or both of the instruments represented in Figs. 427 and 431 may be used, as also the one employed for the introduction of the gold. During this part of the operation the instrument may be held as before, or as seen in Fig. 440, which permits a much greater amount of force to be applied than when held in any other manner.

Fig. 439.

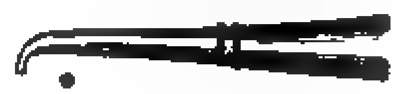
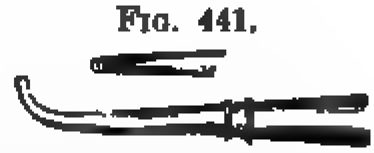


Fig. 440.

Nearly the same method and the same instruments are required for filling a corresponding cavity on the opposite side of the jaw. When practicable, the forefinger of the left hand should be placed on the palatine surface of the tooth, and the thumb against the buccal surface, and in addition to the instruments recommended for the right side of the mouth the one shown in Fig. 425 may be very conveniently employed to introduce the gold; also Fig. 427 or 441 in condensing the surface of the filling. The writer finds this last particularly valuable in very many cases.

Fig. 441.



A cavity in the posterior approximal surface of a superior bicuspid on either side of the mouth can, in the majority of cases, be as easily filled as one in the anterior approximal surface. The position of the left hand is very nearly the same, and in the introduc-

tion of the gold the first folds are placed against the palatine wall of the cavity. By commencing on this side the operator is enabled to lay the folds more compactly than he could were he to commence at any other point. He also has a more perfect control over the instrument in this part of the operation, and has a better view of the cavity during the introduction of the gold. For consolidating the filling, the instruments represented in Figs. 426, 427, and 432 are as well adapted to the purpose as any that can be employed.

When the mouth of a patient is large, a filling can often be introduced with nearly as much ease in the posterior approximal surface of a first or even a second upper molar as in that of a bicuspid; but when the mouth is small and the cheeks fleshy, it often becomes a difficult and perplexing operation, although the same method is used; yet, as it is absolutely necessary to the introduction of a good filling that the operator should see the cavity and witness every part of the operation, his ingenuity is often taxed to the utmost in contriving the most suitable means to enable him to do it. A number of instruments for drawing back the corner of the mouth have been invented, but the writer believes there are none so well suited to the purpose as the thumb or forefinger of the left hand of the operator. If the operator will accustom himself to the use of a small mouth-glass held in the left hand whilst operating, he will be spared many back-breaking efforts to keep in view fillings on posterior surfaces. It is necessary to become familiar with the apparently reverse motion of the instrument as seen in the glass; also to accustom the three fingers of the left hand to act independently of the thumb and forefinger. But one of the most careful and skillful operators of this or any other country, Dr. Maynard, assures us that he works from a reflected view in the glass with the same ease as where he has a direct view of the cavity, and obtains, in very many cases where he uses the glass, an accuracy of view which direct vision could not give him.

Before dismissing this part of the subject, there is one point to which the attention of the young practitioner should be particularly directed. Many, in other respects tolerably good, operators are most likely to fail in not introducing a sufficient quantity of gold in the upper palatine portion of the cavity. The author frequently meets with cases in which the walls of the cavity are perfectly sound and every other part of the filling well consolidated; but here, upon the application of a wedge-pointed instrument, the gold is easily perforated. He would therefore advise the inexperienced operator to test this by severe pressure with a sharp, wedge-pointed instrument, as well, indeed, as every part of the filling, before leaving the opera-

tion. There is also one other precaution applicable to fillings in the approximal surfaces of the incisors and cuspids, as well as of the molars and bicuspids; it relates to overlapping portions of gold under the free edge of the gum, which must be carefully and completely removed before the operation can be regarded as complete.

In filling a cavity in the buccal surface of an upper bicuspid or molar, on either side of the mouth, the gold may be introduced with the instruments represented in Figs. 423 and 433. The latter is better adapted for the left side, but may also be used on the right. The straight, wedge-pointed instrument may also be advantageously employed on this side. The first folds of gold should be placed against the posterior wall, proceeding from behind forward, and pressing the folds against each other as compactly as possible. When the cavity has a large orifice and is rather shallow, or in other respects badly shaped for the retention of the gold, the operation is often tedious, difficult, and perplexing. But under favorable circumstances a filling may be almost as readily introduced here as in any other part.

The palatine surface of a bicuspid or of a molar is rarely attacked by caries; on the latter it is usually seated in a depression at the termination of a fissure leading from the posterior depression in the grinding surface. It is usually situated near the posterior palato-approximal angle of the crown, about half way between the gum and the coronal extremity of the tooth. It sometimes happens that the walls of these fissures are affected with caries throughout their whole extent, requiring to be filled from the depression in the grinding to its termination on the palatine surface. In this case the portion of the cavity on the grinding surface may be first filled; then the operator may proceed to fill the palatine portion in the same manner as if it were a simple cavity, placing the first folds of foil, in the case of a right molar, against the upper and posterior side of the opening with an instrument like the one represented in Fig. 433. Great care is necessary to prevent the instrument from slipping. It often happens, too, that the orifice becomes choked with foil before the cavity is half filled. This, indeed, is liable to occur in filling any cavity in any tooth; and when it does happen, unless a sufficient amount of pressure is applied to make a free opening into it, the filling will be imperfect and the object of the operation wholly defeated. When the cavity is situated in a left molar, the gold may be introduced with the instruments represented in Figs. 423 and 436, placing the first folds against the upper wall of the cavity and proceeding downward.

A tubercle of greater or less size is sometimes found on the

anterior palatine surface of a molar, near the crown. Between this and the body of the crown a deep impression is often seen, which becomes the seat of caries; but the removal of the diseased part and the introduction of a filling is so simple that a special description of the operation is not deemed necessary.

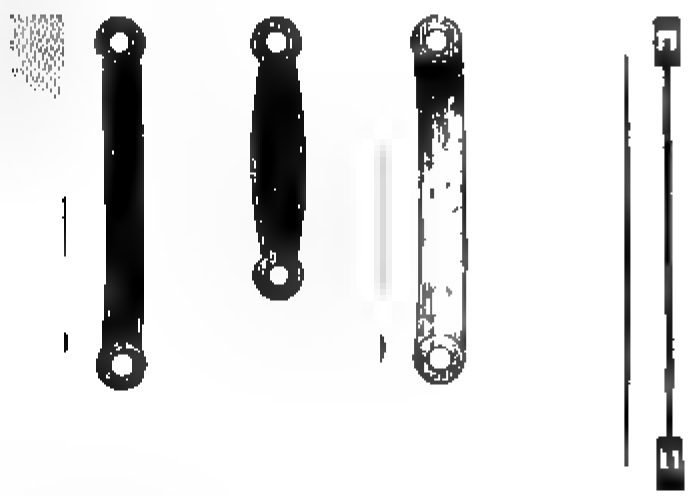
II. *With Cohesive Gold Foil.*—In forming cavities in the approximal surfaces of bicuspids and molars it is essential, in the majority of cases, to separate the teeth either by means of pressure or by cutting away a portion of the crown.

When they are very close together it is often impossible to gain sufficient space by pressure, and it then becomes necessary to resort to the enamel chisel and file, or disk, cutting away a portion from each tooth when both are decayed, and from one only if the other is in a sound condition. The former practice in separating these teeth was to cut away so much of the entire approximal surface as to form a V-shaped space of sufficient extent to enable the operator to reach the cavity easily. But by this method the crown of the tooth was disfigured and a space formed in which food readily collected and became a source of considerable annoyance. To avoid this, the practice now is to cut through the grinding surface to the approximal cavity, mortising this opening, and thus preserve the palato- and bucco-approximal angles, while at the same time the shape of the opening through the grinding surface materially assists in the retention of the filling. In preparing these cavities for cohesive gold foil, at least two good retaining points should be made at the cervical wall and two under-cuttings at the cusps, which have been preserved by the method of gaining space just described. But one of these retaining points, in connection with the two under-cuttings at the cusps, will often secure the filling when the nature of the case will not allow of more being made.

In preparing a cavity on the posterior approximal surface of a molar tooth access is obtained by cutting through the grinding surface in the manner before referred to; then, by means of instruments more or less curved, the buccal and palatine walls are made parallel with each other, under-cuttings formed at the cusps, and retaining points drilled in the cervical wall at different angles. Advantage is also gained from having the cervical wall slightly undercut. In introducing the gold into a cavity of this nature many prefer placing a polished plate of metal or a matrix back of the cavity, in the space between the teeth, and condensing the gold firmly against it in building up this portion of the crown. By this method a good support is obtained, and after all the gold necessary is introduced and consolidated the metal plate is removed.

Fig. 442 represents a set of loop matrices, consisting of thin, flexible steel bars and a milled thumb-screw. To use them, one of the proper size is selected, the head with the smooth hole being passed

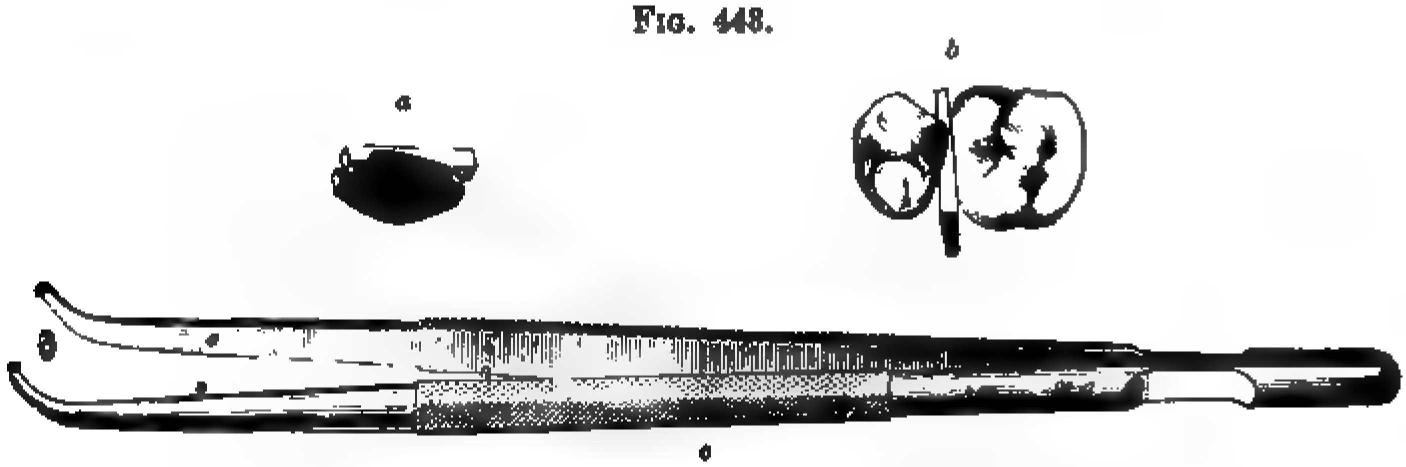
FIG. 442.



over the thumb-screw; the screwed head is then bent around and the loop screwed to its place on the tooth.

Fig. 443 represents an ingenious mechanical aid of this description, invented by Dr. Louis Jack, called a matrix; *a* shows the con-

FIG. 443.



cave and wedging sides of a matrix, and *b* shows a matrix placed between two teeth ready to wedge and fill. *c* represents the form of pliers for placing a matrix in position.

The points especially notable in the use of a matrix are, to cut away the masticating surface of enamel to the depth of the cavity; to prepare the edges flat and smooth; to cut down to sound bone in the neck of the tooth, forming the base of the cavity, and shaping it so that the matrix will fit accurately on the cervical wall. Having excavated the cavity and cut a retaining groove along the buccal and palatal walls (terminating at the very surface of the masticating walls of the enamel), select a matrix the concaved surface of which matches the cavity. Then, after applying the rubber dam, finish

and dry the cavity, place the matrix, and secure it with wedges of boxwood, which, being hard and dry, require very little forcing. The

FIG. 444.

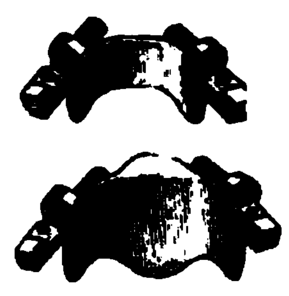


FIG. 445.

filling may then be done with the ease and certainty of a crown cavity with strong walls.

Figs. 444 and 445 represent the double screw matrices designed by Dr. W. A. Woodward, which, like those of Dr. Jack, occupy a single interdental space.

Figs. 446, 447, 448, 449, and 450 represent Dr. T. W. Brophy's matrices and their use, in the forms of bands and screws.

FIG. 446.

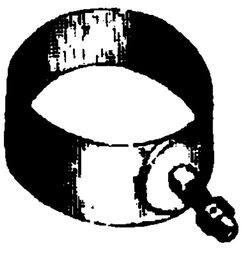


FIG. 447.

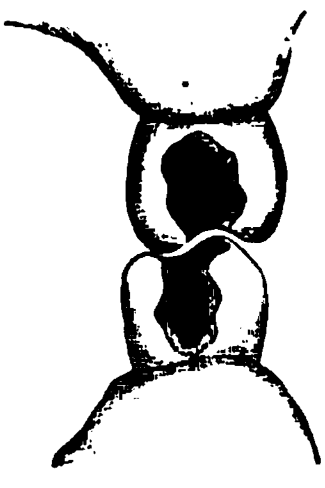
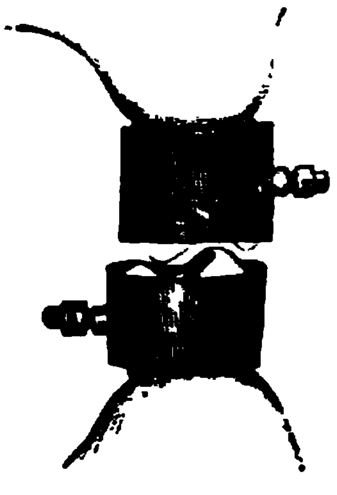


FIG. 448.



Soft or non-cohesive foil should be used for the cervical margins and for the first half of the filling, because of the ease with which

FIG. 449.

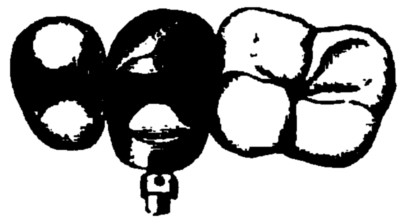
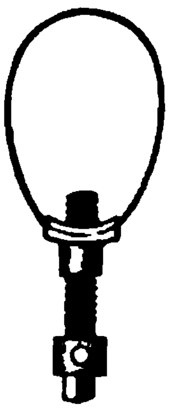


FIG. 450.



it may be adapted to the cavity walls and the rapidity with which it may be inserted; the masticating surface to be finished with cohesive gold. Wedge-shaped pluggers are the most desirable forms

with which to condense the soft foil. If amalgam or cement be used the band should be oiled on the inner surface, to prevent the filling from adhering to it.

Figs. 451 and 452 represent Dr. W. B. Miller's matrices and their use.

This matrix is commonly held firmly in place by reason of its duplex spring expansibility, but it may be additionally supported

Fig. 451.

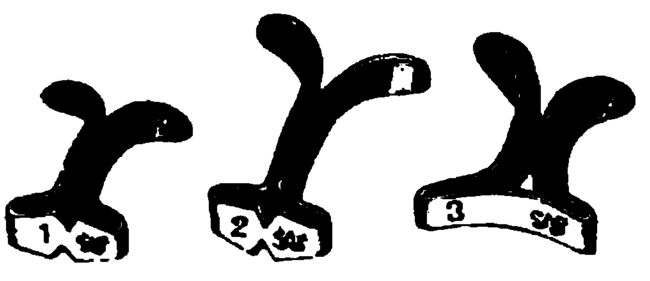
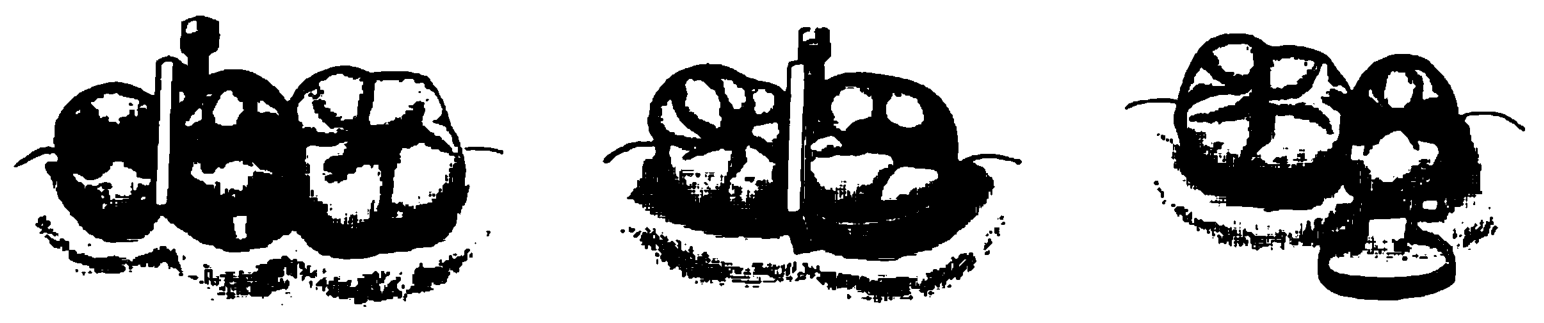


Fig. 452.

by a wedge of wood driven between the springs. Either the concave or convex edges go next to the gum, according as the cervical

Fig. 453.



margin of the cavity is upon or beneath the gum, and a thick or thin matrix will be indicated by the width of the space between the teeth.

Fig. 454.

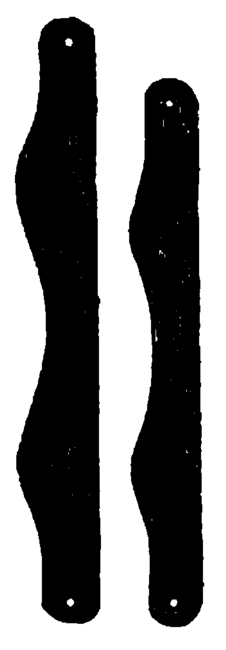
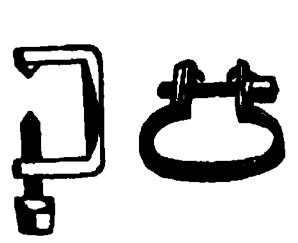


Fig. 455.



Dr. Guilford's band matrices and clamps are represented by Figs. 453, 454, and 455.

Dr. Frank Creager's loop matrices are represented by Fig. 456.

This series of loop matrices consists of eight thin, flexible steel

bars and a milled thumb-screw. The bars have heads on each end, with eyes, in one of which a thread is cut to fit the thumb-screw. To use them, select the proper size for the case in hand, pass the head with the smooth hole over the thumb screw, bend the screwed head around, and screw to place on the tooth.

The Herbst Matrix consists of a band of soft German silver, of the thickness 32 Am. gauge, about one inch and a half in length, and as wide as is necessary to cover the cavity in the proximate surface of the tooth. It is first fitted to the crown by bending it around, bringing both ends of the band to the buccal surface, and drawing them tightly together by the pliers. When the band is thus made to fit perfectly to the crown of the tooth to be filled, it is carefully

FIG. 456.

removed and the joint soldered with soft solder, using muriate of zinc solution as a flux. This matrix is prepared before excavating the cavity.

For the use of gold by the Herbst method, matrices are also used made of gum shellac, which is moulded to the tooth crown in a plastic condition, and then trimmed to the proper shape so as to form a supporting wall and not interfere with the introduction of the gold.

"Dr. Perry's matrix consists of a strip of metal to go about half way around the tooth and having a hole drilled through each end (Fig. 457). It is fastened around the tooth by means of a threading cord or floss silk, which is passed through the holes and tied fast with a double or treble knot (Fig. 458). The knot can be pushed out of the way upon one side of the tooth. The usual fault with matrices of this character is that they are made in different parts, one or more of which is liable to fall upon the floor, and they are in other respects difficult to manage. This one is very simple. You pass the threads through the holes in the ends, place the matrix where you wish to have it, wrap the thread around the tooth, and

tie it (Fig. 459). If it stretches a trifle there is no harm done, because in packing gold there is a greater certainty of a close fit at the margins if the matrix yields a little. The matrix is made of very thin steel, and to prevent it from cutting the thread with which it is tied small pieces of metal are soldered to the ends, and the holes for the thread are drilled through those extra pieces of metal. This makes it so thick and firm that the thread can be drawn tight without danger of cutting it. The matrix is not universal in its applica-

FIG. 457.

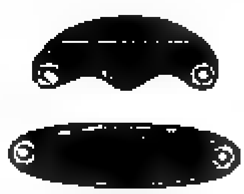


FIG. 458.

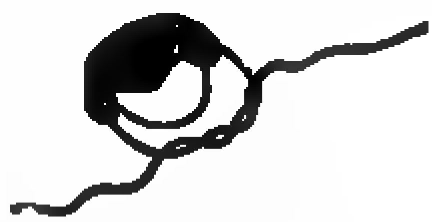


FIG. 459.

tion, and I would not be without the others; but it is, in certain cases, the best device that I have used. The holes are drilled in such a manner that the thread comes near the cervical wall, and the matrix is made to hug the tooth at that point. If it does not, a wedge of wood dipped in sandarac varnish and pushed between it and the adjoining tooth will cause it to fit well at the cervical border. This matrix is equally suited for gold or other plastics. It is particularly neat when amalgam is used, and it is often desirable to leave it on

FIG. 460.

FIG. 461.

the tooth for a day or night. To avoid obstruction I use many narrow forms of this matrix, some of which do not cover more than one-third or one-half the length of the tooth.

"There is another use to which the same matrix may be applied. It is that of adapting it by a simple method of binding and tying to any of the other teeth. Reference to the cuts will show how it can be easily applied to the incisors, which almost always should be filled from the lingual side (Fig. 460), and to the bicuspids and molars

(Fig. 461), which can be sometimes filled from the buccal or lingual side without cutting down from the grinding surface. To one who reveres the shapes of the teeth this is an operation that is most satisfactory, and by the aid of this simple matrix it is more easily performed."

Split teeth may be secured by gold bands or collars used in connection with oxychloride or oxyphosphate of zinc between the fractured surfaces.

"Large contour restorations may be expeditiously made by means of the collars set tightly on the thoroughly prepared and dried tooth, which can then be filled with gold or gutta-percha or cement. For cutting the collars to conform to the cervical curves, an engine corundum point or Herbst rotary file will serve the purpose, and a collar so cut is shown by Fig. 462. To keep the gold as much as possible out of view, the collar should be cut as seen in Fig. 463. Platinum collars will be required when the filling is to be of amalgam, but a gold collar may be varnished with a mere film of collodion, copal,

FIG. 462.

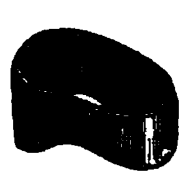


FIG. 463.

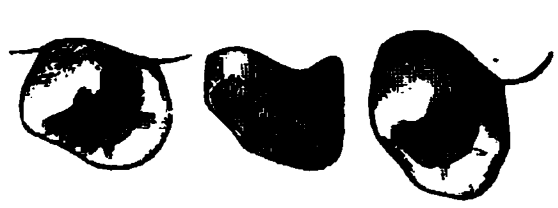


FIG. 464.

sandarac, or shellac varnish, at the part which is to come in contact with the amalgam, and then with proper care a dry amalgam will not combine with the gold of the collar. A thin collar, somewhat larger than the tooth, can be put in place, and a wedge of wood driven between the remaining portion of the tooth and the collar, to form a matrix, which, after the filling has been built in it, can be removed by first withdrawing the wedge. Such a matrix is illustrated in Fig. 464, and by this means many large and complex fillings may be rapidly and perfectly constructed."

In filling grinding surface cavities in the molar teeth, where the decay has extended along one or more of the crown fissures, with cohesive gold foil or crystal gold, the gold is first introduced into the bottoms of the crown fissures and built up to their orifices, thus completing the filling of these fissures before the central cavity is filled. The fissures or sulci should be opened to their extreme limits and the ends be made round. Small curved chisels and fissure-drills are well adapted for preparing sulci, and the excavation should be commenced at the central part. In preparing cavities extending in the form of sulci or fissures over the buccal and palatine surfaces of the bicuspids and molars, all projecting portions of

enamel should be cut away, so as to allow these cavities to be but little larger within than at their orifices; and the ends of the groove, which are usually shallow, should be made as deep as the centre. One retaining-point may then be made in each of the two walls forming the ends of the groove-like cavity, or one retaining-point in the posterior wall, in connection with an under-cutting in the anterior one, will answer for the retention of the filling. In introducing the gold into a cavity of this form the retaining-points are first filled and the gold built across the floor of the cavity from one to the other, and from the base thus formed to the orifice. When a cavity upon the buccal or palatine surface extends under the free margin of the gum, it is necessary to either force the gum away by pressure with pledgets of cotton saturated with chloride of zinc, when the cavity is not too near the pulp, or to remove the portion overlapping the cavity. The hemorrhage which follows this latter method may be checked by any of the hæmostatic agents in use, such as tannin, phenol sodique, creosote, powdered subsulphate of iron, etc.

The application of chloride of zinc will prove very effectual in such cases; also nitrate of silver, but the latter agent has a tendency to discolor the dentine.

FILLING THE INFERIOR INCISORS AND CUSPIDS.

The operation of filling a lower incisor or cuspid is far more difficult than filling an upper.

The constant tendency of the lower jaw to change its position is embarrassing to the dentist in operating on any of the teeth in it, and in case of the incisors and cuspids it is sometimes peculiarly perplexing. To prevent this all the effort the operator can make with his left hand is frequently required. From the backward inclination, too, of these teeth, it rarely happens that the gold can be introduced from the lingual side of the arch; consequently it is necessary to make the space as wide anteriorly as posteriorly. But as the teeth are comparatively small, the separation, when made with a file, chisel, disk, etc., should be no wider than is absolutely necessary for the removal of the diseased part and the introduction of the gold. When, however, it can be done with safety, the separation should be made with a piece of rubber or other substance between the teeth, in the manner before described, or by rapid separation.

While operating on the lower teeth the head of the patient should occupy a more perpendicular position than while operating on the upper; this may be done either by lowering the seat or raising the

head-piece of the chair. When by the latter it will be occasionally necessary for the operator to stand upon a stool five or six inches in height.

In filling a cavity in the right approximal surface of a lower incisor or cuspid with *non-adhesive gold foil* the following method is recommended. The cavity being prepared and a sufficient quantity of gold foil made into a small roll or folded lengthwise, as the operator may prefer, with the left arm over the patient's head, the chin is gently grasped with the left hand, while the thumb is placed against the lingual surface of the tooth, the forefinger serving to direct the gold and point of the instrument and also to depress the lower lip. The folds of gold, in their introduction, are pressed firmly against the lower wall of the cavity. The instrument employed for this purpose may be shaped like the one represented in Fig. 465, with a very small, wedge-shaped point, and held as in Fig.

Fig. 465.

Fig. 466.

434. The consolidation of the gold may be effected partly with the same instrument, partly with a round-pointed one shaped as shown in Fig. 466, and partly with an instrument shaped as in Fig. 432. The tooth should be firmly held between the thumb and forefinger of the left hand, to prevent it from being moved in its socket by the pressure of the instrument.

When the incisors are very small and the caries has spread over a large portion of the side of the tooth, it is often difficult to form a suitable cavity for the retention of the filling without penetrating to the pulp cavity. In such cases the patience and skill of the operator are frequently taxed severely in obtaining a sufficiently secure support for the gold. But this he can usually do if he can make the bottom of the cavity as large as the orifice, even though it have but little depth.

The manner of introducing a filling in the left approximal surface is very similar. The left arm and hand, as well as the thumb and forefinger, are all disposed of in the manner just described. The same instruments, too, may be employed for introducing and consolidating the gold, though in the first part of the operation the instrument, Fig. 428, may often be advantageously substituted for the one in Fig. 465. The instruments known as "rights and lefts," of different sizes, are very serviceable for filling all approximal cavities.

Nothing has been said with regard to fillings in the labial or lingual surfaces of lower incisors and cuspids. Although caries rarely attacks either of these surfaces of a lower incisor, it does sometimes develop itself in the labial surface of a cuspid; but the operation of introducing a filling here is so simple that a separate description of the manner of it is not deemed necessary.

The operation of forming cavities in the inferior teeth and introducing *cohesive gold foil* and *crystal gold* is the same as that described for the superior teeth, and a second description is therefore not considered necessary. As absolute dryness is essential in manipulating the cohesive forms of gold, the reader is referred to the various methods and appliances before described for drying cavities and protecting them from moisture. In filling the inferior teeth, the rubber coffer-dam will be found to be a valuable appliance for excluding all moisture from both the gold and cavity, and the saliva-pump an efficient adjunct to this dam for relieving the mouth of the saliva as it accumulates in prolonged operations. For controlling the movements of the tongue, a tongue and duct compressor has been used in connection with pads of bibulous paper placed upon the mouths of the ducts beneath the tongue. Prepared spunk has also been used successfully on the mouths of the sublingual and submaxillary ducts for controlling the flow of saliva. The rubber dam, however, will answer all requirements when used in connection with clamps.

FILLING THE INFERIOR MOLARS AND BICUSPIDS.

In filling a cavity in the grinding surface of a right lower molar or bicuspid, the operator may stand on the same side of his patient and a few inches higher than while operating on an incisor or cuspid. With his left arm placed over his patient's head, the tooth may be grasped with the thumb and forefinger of the left hand, while the middle finger is placed by the side of the chin; the other two should be placed beneath it. After preparing the cavity, *non-cohesive gold foil* may be introduced with an instrument like the one represented in Fig. 436, and held as shown in Fig. 430, pressing the folds against the posterior walls of the cavity.

In condensing the gold after the cavity is filled, use the instrument represented in Fig. 437. Sometimes, however, a greater amount of force can be exerted when this instrument is held in the manner shown in Fig. 440, previously wrapping it with the corner of a napkin to prevent the small part of the instrument from hurting the little finger. *The kind of instrument and the manner of holding*

it will, after all, have to be determined by the operator. During the introduction and consolidation of the gold the lower jaw should be firmly held with the left hand, to prevent it from moving and from being too much depressed. This precaution is the more necessary, as the muscles of the lower jaw and the articular ligaments are seldom strong enough to resist the amount of force required in the operation.

In filling a cavity in the grinding surface of a tooth on the left side the dentist may sometimes operate to greater advantage by standing on the same side. In this case the commissure of the lips should be pressed back with the thumb of the left hand, placing it on or against the tooth to be filled, while the forefinger passes in front of the chin and the other three beneath it. As a general rule, however, he will be able to operate more conveniently by standing on the right side of his patient and holding the tooth and the chin in the manner before directed. In either case the gold, in its introduction, should be pressed against the posterior wall of the cavity.

The foregoing general directions will be found, for the most part, applicable to the introduction of a filling in the approximal surfaces. When the crowns of the teeth are long and the cavity situated near the gum, the operation is sometimes very difficult and tedious, requiring all the patience and skill the dentist can exercise to accomplish it securely. This difficulty is increased when the shape of the cavity is unfavorable for the retention of the gold; or, in other words, when the cavity is shallow and has a large orifice. There is also another very serious difficulty which the operator encounters in the introduction of a filling in the approximal and also in the buccal surface of a lower molar or bicuspid. The flow of saliva is often so profuse that the whole of the lower part of the mouth is completely filled, and the tooth is inundated before it is possible to introduce a sufficient quantity of gold to fill the cavity. This not only retards the operation, but it also renders it more difficult and perplexing; for it is necessary to force out every particle of moisture from the cavity and from between the different layers of gold before the necessary cohesive attraction between them can be secured. If this is not done or, at any rate, if all the moisture is not forced from the cavity and the gold sufficiently consolidated to render it impermeable to the fluids of the mouth, the operation will be unsuccessful to a great extent; hence the rubber dam is a valuable adjunct.

Ordinary foil (non-cohesive), when introduced in folds lying parallel with the sides of the cavity, keeps its place by the close lateral contact of the folds against each other and the walls of the cavity.

Hence such fillings may prove successful, although done "under water," provided the lateral pressure is sufficient to force out the saliva from between the layers of foil. But if the folds are laid in parallel with the bottom of the cavity, the operation will fail, in consequence of the scaling off of the successive layers which have no adhesion. Crystal gold and cohesive foil fillings depend for their success upon the perfect adhesion of their component pieces; therefore the slightest moisture, or even dampness, while being introduced is fatal to their durability.

For the purpose of obviating this difficulty a variety of means have been proposed, the most important of which have already been described and need not be again referred to.

In the introduction of non-cohesive gold on the right side, it may be pressed against the buccal wall of the cavity on the left side, or against the lingual wall. Either of the instruments represented in Figs. 422 and 423 may be employed for the introduction of the gold, whether the cavity be situated in the anterior or posterior approximal surface of the tooth, and may be held in the hand in the manner shown in Fig. 430 or 434.

In filling a cavity in the lingual and posterior approximal angle of a first or second bicuspid, and especially from the loss of the tooth behind it, when there is a backward inclination of the organ, great care is necessary to prevent the instrument from slipping and wounding the lower lip. The most convenient position for the operator in this case is on the left side and partly in front of the patient. The tooth may then be firmly grasped between the thumb and forefinger of the left hand, or the thumb alone pressed against the outside of the tooth; in either case it is to be used as a rest for the ring finger of the right hand during the introduction and consolidation of the gold. But the locality of the cavity is such, especially when the mouth of the patient is small, that it can only be seen with great difficulty. Hence the operator is constantly liable to place the point of the instrument on one side of the orifice against an overlapping portion of gold, which, when pressure is applied, is cut through or detached. The instrument thus comes in contact with the hard, smooth enamel, and unless the hand is so guarded as to control its motions it is liable to slip and wound some part of the mouth, especially the lower lip, which accident, unless proper precaution is observed, may occur in filling any tooth.

Among the principal difficulties which the dentist encounters in filling a cavity in the buccal surface of a lower molar, apart from that of keeping the cavity dry until the gold is introduced, is the contact of the lower and inner part of the cheek with the tooth.

This may, to a considerable extent, be prevented, and the commissure of the lips at the same time pushed back with the forefinger of the left hand of the operator, which also will serve, when the cavity is shallow and the orifice large, to hold the gold in place until a sufficient quantity is introduced to obtain support from the surrounding walls. In operating upon the bicuspids it is only necessary to depress the corner of the mouth to obtain free access to the cavity.

For the introduction of the gold on the right side, either of the instruments represented in Figs. 423 and 433 may be employed, but on the left side the latter will generally be found most convenient. A straight, wedge-pointed instrument (Fig. 467) can often be advantageously used in introducing the foil in either of the right bicuspids, and sometimes even in the first molar. This instrument can also often be used in filling a cavity in the grinding surface of a molar of either jaw, but oftener in the upper than the lower. It is scarcely necessary to say that the introduction of the gold should commence behind and proceed forward. The instruments represented in Figs. 426, 435, and 439 may be used in consolidating the foil.

Fig. 467.

It may be well to mention here that in filling a molar or bicuspid on the left side in the lower jaw, whether in the grinding, approximal, or buccal surface, the back of the chair, if so constructed as to admit of being moved, should be thrown five or six inches further back, to lower the head of the patient and give the face a more horizontal inclination. By this means the operator is enabled to approach the locality of his manipulations with greater ease, thus enabling him to exercise a more perfect control over his instrument, as well as over the mouth. But if the back of his operating chair is stationary, he should stand upon a stool of five or six inches in height.

The precaution of removing all the overlapping portions of gold should never be omitted, and this sometimes constitutes a difficult part of the operation, especially when the cavity extends under the margin of the gum. For this purpose some of the files represented in Fig. 413 may be very advantageously used. Some are made straight at each end, others are curved. The cutting-burrs operated by the dental engine, and also the corundum and sand-paper disks, are useful instruments for removing surplus gold.

The manner of building up the whole or a part of the crown of a tooth will now be described.

CONTOUR FILLINGS.

The term "contour" signifies "the line that bounds, defines, or terminates a figure;" hence a "contour filling" is one that is made to conform to the line that defined the contour of the lost tooth tissue; in other words, the filling material is built up to such a degree as is necessary to restore the original form of the crown of the tooth.

It is scarcely to be expected that any one who has not had considerable experience in filling teeth, and acquired a high degree of dexterity in the use of instruments and the working of some one or more of the preparations of gold employed for the purpose, such as cohesive gold, will, simply from any directions that can be laid down upon the subject, be able at once to perform the operation of building on the whole or part of the crown of a tooth. But it is hoped that the following description may serve as a guide to those who have never attempted it, and may wish to exercise their mechanical and artistic abilities on this, the most difficult of all operations in dentistry. Those only who are aiming at high excellence in this department of practice will be likely to undertake it; and should their first efforts prove unsuccessful, the increase of skill they will have thus acquired in the use of instruments will inspire new confidence, and ultimately, by perseverance, enable them to achieve the object of their wishes.

The operation, to be successful, must not only be performed in the most perfect manner, but the tooth itself must be situated in a healthy cavity and firmly articulated. Under other circumstances it would be useless to attempt the restoration of the organ. The general system, too, should be free from any preternatural susceptibility to morbid impressions.

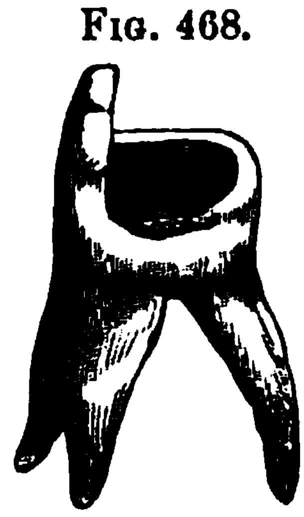
A tooth on which this operation is called for has, in nearly every case, suffered so much loss of substance as to render it necessary, in cases where the pulp of the tooth is not exposed, that great care should be exercised in preparing the cavity for such a large mass of filling material, especially gold, and securely anchoring it. Where the exposure of the pulp of the tooth necessitates the destruction and removal of this organ the operation of "contouring" is much less difficult, as the pulp-chamber affords secure anchorage for the filling. Where the pulp has previously perished from inflammation and suppuration, the permanent preservation of the organ cannot be counted on with as much certainty as when it is destroyed by extirpation or by the application of an escharotic two or three days before the performance of the operation. Its destruction by the suppurative process is more apt to be followed by alveolar ab-

scess; and this, having once established itself, is seldom so completely cured as to prevent the liability to its recurrence. Still, if the operation is determined on, the parts of the extremity of the root must first be restored to health; for without this it should never be attempted. The preparatory treatment in cases of this sort, as well as in cases of simple morbid secretion escaping from the root, is given in another chapter.

In describing the operation we will commence with the first molar of the left side of the superior maxilla. We will suppose that about three-fourths of the crown has been destroyed by caries and that the buccal wall is the only portion remaining, the pulp being more or less exposed. This is to be destroyed and extirpated to the extremity of each root; the decayed portions of the tooth are then to be removed, and the central chamber enlarged until the wall of dentine on the palatine, anterior, and posterior approximal sides are only about one line in thickness. On the inside of this wall a shallow groove or undercut is made and also retaining points, to give additional security to the gold.

The tooth as now prepared is represented in Fig. 468, and, after the application of the rubber dam, is ready for the introduction and building on of the gold. But before describing the manner of doing this it may be well to say a few words with regard to the preparation of gold most proper to be employed. For filling the roots, non-cohesive gold foil is the best. If the leaves are thick, weighing from fifteen to twenty grains, it should be introduced in very narrow strips, without folding, in the manner described in another chapter; if leaves of four or six grains are preferred, it may be cut in strips varying from an eighth to a quarter of an inch in width, according to the size of the canal in the root, and then rolled or made into very narrow folds. For the central chamber and crown, gold possessing cohesive properties should be employed; although this property may, to a degree, be imparted to common gold foil by slightly annealing immediately before using, cohesive gold foil possesses it in a higher degree, and this also requires to be annealed. Either kind of foil, therefore, or crystal gold may be employed. The operation, however, can be better performed with the cohesive foil or crystal gold than with the non-cohesive foil. Crystal gold is often used to fill the central chamber and act as a base upon which to build the cohesive gold foil.

FIG. 468.



As the manner of filling roots is described in another place, we shall commence with the pulp cavity. The gold, supposing it to

be cohesive foil, is loosely rolled into a fold or rope, from which pellets are cut. A sufficient number of these having been prepared, the surfaces against which the gold is to be placed are made perfectly dry by wiping with Japanese bibulous paper or absorbent cotton. This done, one of the pellets is placed in the central chamber with pliers, pressed into a retaining point, where the formation of such points is necessary, and consolidated with a small-pointed condensing instrument; another and another is added, each being consolidated as the first, until a sufficient number have been introduced to fill this chamber. The process of consolidation is now to be repeated and continued until no part of the gold can be made to yield to the pressure of the instrument; then additional pellets are applied and condensed as in the first instance, forcing those placed against the surrounding wall firmly and compactly into the groove or undercut made in it, thus securing for the entire mass the greatest possible stability. Again, pellet after pellet is applied, pressing those placed along the outer edge firmly against the enclosed margin of dentine and against the buccal wall of the tooth, until a solid mass considerably larger than the portion of the crown to be supplied shall have been thus formed. The same result may be obtained much more rapidly by using the gold in the form of a ribbon. In this case fold after fold of the gold is introduced, each fold being thoroughly welded and consolidated as introduced.

For the complete solidification of every part of the gold and the welding of every piece to the adjoining ones, a number of instruments are required, with serrated points, which are represented in the figures illustrating the instruments employed in the use of the cohesive forms of gold. For some parts of the operation a straight instrument can be employed most advantageously; for other parts, one slightly bent near the point; and for others, one bent at right angles with the stem. The kind most suitable for each case must be determined by the judgment of the operator. One, perhaps, may use very efficiently an instrument in a particular locality and for a certain purpose, that another, for the same purpose, would handle very awkwardly. But for completing the work of consolidation, all agree that very small-pointed instruments are indispensable. The consolidating or building instruments may consist of Varney's hand-mallet pluggers, or the points of the automatic or engine mallets.

As the cohesiveness of the gold is destroyed by the contact of liquids, it must be kept absolutely free from moisture during the entire process of introducing and consolidating the metal. But if, notwithstanding every precaution, the saliva should come in contact with the gold before its complete introduction, the unfinished surface

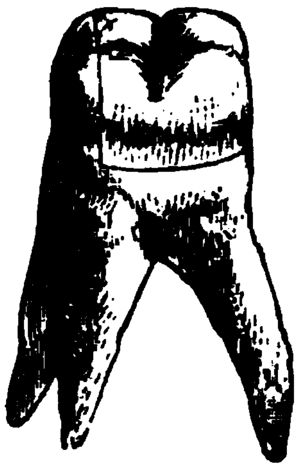
must be thoroughly consolidated, then dried with some good absorbing substance, scraped, burnished, dried again, and made rough with a sharp-pointed instrument. To this surface fresh portions of gold can now be united, and sometimes made to adhere quite firmly, but often it is necessary to drill retaining points into the gold and continue the operation from these points. The use of the rubber dam and other appliances now enables the operator to perform prolonged operations without the danger from moisture which formerly existed.

The next step is to consolidate thoroughly every part of the surface. This may be commenced with the larger-pointed instruments. After going over it ten or a dozen times with these, smaller points may be used, and these again changed for still smaller, until no more impression can be made upon it than upon a solid ingot of pure gold.

It now remains to cut the surface until the gold is made to assume very nearly the shape of that portion of the original tooth the loss of which it supplies. The plug-finishing burrs operated by the dental engine, the files for finishing the surface of fillings, and the corundum and sand-paper and stone disks and points, will be found serviceable for such operations. In doing this an opportunity is afforded to the operator for the display of much artistic skill and ingenuity. While shaping the grinding surface the patient should be requested, from time to time, to close the mouth, that the depressions in it may be made to correspond to the cusps of the tooth with which it antagonizes, so that these two may touch simultaneously with the other teeth of the upper and lower jaws. This part of the operation is always tedious, usually requiring more time than for the consolidation of the gold. The use of articulation paper may facilitate this part of the operation.

The surface of the gold may now be rubbed with properly shaped pieces of Arkansas or Hindostan stone or with pulverized pumice until all the scratches left by the files are removed; then polish with crocus and a burnisher. The appearance of the tooth as thus restored is shown in Fig. 469.

Fig. 469.



As it is impossible to perform the entire operation at one time, it may readily be divided into three parts, the *first* consisting in the extirpation of the pulp (when necessary) and the preparation of the tooth, the *second* in the introduction and solidification of the gold, the *third* in giving to the metal the proper conformation and in finishing the surface. The time required for the

first, supposing the operation to be like the one just described, may vary from one and a half to two and a half hours; for the second, from two to three and a half hours; and for the third, from two to six hours, according to the difficulties to be encountered, the ability of the dentist, and the completeness of his preparation for the operation. Some, perhaps, may prefer crystalline or sponge gold, supposing it to be more easily welded than cohesive foil; but as the manner of working this variety of gold has already been described, it will not be necessary to give additional directions for its use.

The late Dr. M. H. Webb, an expert operator in contour work, gave the following directions for completing such an operation:—

"When the foil has been prepared and impacted as described, and so that the substitution for the lost tissue is complete, a fine saw or suitable file should be used to cut away the surplus material and to aid in making the filling conform to the original contour of the part, after which narrow strips (a line or ⅛-inch wide) cut from fine emery cloth should be so manipulated as to properly form and finish the surface of the gold. When this has been done and the rubber dam removed, the finishing should be completed by the use of fine pumice and silex upon linen tape, as before suggested. The gold at the masticating surface should be finished with fine burrs, and by their use made concave or to conform to the original type of the part operated upon. The gold should be so impacted as to be flush with the prepared margin of enamel, yet even then made concave when such concavity is indicated. Fine burrs should be used for the purpose of trimming and shaping such fillings, because the form of the remaining part or parts of the cusps and prepared edges of enamel against which the gold is placed may be changed and the teeth made less useful when corundum cones are used. The polishing of the gold upon the surface referred to may be done with pumice and silex, mounted upon suitably shaped points of wood, leather, or rubber.

"Whether the cavity is large or small, the gold ought to be built out to the original contour of the part and at its periphery, a little beyond the margin, then finished down to the surface of the enamel, and the whole filling made to conform to the line that defined the contour of the lost tissue. If the gold be not impacted against and be not flush with the edges of the enamel, the operation is not such as is demanded for the preservation of remaining tissues. A plain surface of gold should not be made, because the tooth thus operated upon and the one adjoining may approximate closely and disinte-

gration of enamel take place near or at the part in contact. Restoration of contour prevents such contact, and this prevention is necessary, especially when the tissues of the organ operated upon are not fully calcified. When operations have been so performed as to entirely prevent fluids or semi-solids from entering between gold and the tissue against which it has been placed, the gold tint may be seen through the light walls or edges of translucent enamel soon after the removal of the rubber dam and completion of the operation. If an opaque or dark line or spot be visible at or near the parts where gold ought to be in contact with dentine and enamel, the operation has been imperfectly performed, and chemical action may soon follow and the entire filling prove a failure."

The operation of building on the entire crown of a tooth should be proceeded with much in the same way as just described for part of the crown. If too large pieces of either crystal gold or foil are used at one time, the surface will become crusted over by the pressure of the point of the instrument, and this will prevent, by any subsequent force that can be safely applied, its thorough consolidation. In this case the general mass will be more or less spongy and the operation imperfect. The dentist should be well assured, therefore, as he progresses with his work, that every successive layer is firmly adherent to the preceding one. To build up an entire crown requires more time; perhaps, also, more skill, as there is no wall of tooth substance to give partial support. In other respects it resembles the previous operation.

It was suggested by the late Prof. Austen, as a plan to avoid much of the tediousness of the second stage of this operation, to fill the pulp cavity, inclosing in the centre a screw-cut, notched, or double-headed pin, and carrying the gold over the edges of the cavity; make this surface somewhat irregular in shape, but finish it smoothly, and trim the circumference to the exact size of the tooth; take a wax or plaster impression of the surface, and fit to the plaster model a lump of gold, having in the centre a hole larger than the pin projecting from the root; shape and polish it *out* of the mouth, then set it in place and secure it by filling with gold around the pin. If the color is not objected to a vulcanite crown could be very perfectly adapted in this manner; or a porcelain tooth could be made, hollow in the centre, with pins or a dovetail to hold a thin layer of vulcanite, by means of which it could be fitted with perfect accuracy to the prepared root. Prof. Austen thought that in this way the root will be less injured, and the union between the gold and the root less disturbed than by the long-continued and severe pressure of the

ordinary operation. While the artificial crown is being made he suggests a temporary gutta-percha crown to prevent any irritation from the projecting pin.

A large portion of the crown of a tooth may be built up with ordinary gold foil if it be of the best quality, but the cohesive preparations, either foil or crystal gold, are preferable. The manufacture, however, of porcelain crowns well adapted to all forms of teeth, as well as the introduction of porcelain facings, or sections of crowns, for attachment to remaining natural portions, afford many advantages in restoring the lost portions of the teeth over that of building up with solid gold. See Fig. 473.

We have endeavored in the foregoing description to point out the general method of procedure in the operation of which we have been treating. We have also noticed some of the precautions necessary to be observed; but unexpected difficulties are sometimes encountered, the peculiar nature of which it is impossible to anticipate. Few, however, are of so formidable a character that they cannot be overcome.

During the operation of building up a portion or the whole of a crown with cohesive gold, if, in condensing it, any part becomes displaced or fails to unite with that already introduced, it should be removed, otherwise the filling will prove defective; and this rule will apply to all fillings of this form of gold. Each piece, as it is introduced, must be firmly attached to that already in position, and no doubt should exist concerning secure anchorage. When a contour filling, which includes a portion or the whole of the masticating surface of a bicuspid or molar, has been properly inserted and the gold built up flush with the margins of enamel, such a surface should be made to correspond to the original surface in form, by making it concave by means of the fine finishing burrs or corundum points used with the dental engine, when it may be polished with pumice and silex, applied by properly-shaped points of wood, rubber, or leather. In all such building up the gold should be carried beyond the margin and then cut down to the surface of the enamel, preserving the original contour of the part as much as is possible. By the aid of matrices the contouring of approximal surface cavities, especially posterior ones, is greatly facilitated, as they enable the operator to adapt and impact the gold in a perfect manner.

To retain the gold of contour fillings in large, saucer-shaped, and other forms of cavities, screws made of fine gold, securely anchored in the dentine, with free ends projecting above the surface around which the gold is built, are available.

Fig. 470 represents Dr. How's retaining screws and instruments

for their introduction. A shows a cone-socket screw-driver with a sliding split tube which serves as an adjustable holder for the screw, in the end of which is a slot, such as the operator may readily cut with a No. 5 separating file. On placing the screw in the holder the driver blade will enter the slot as shown in partial section by B. C shows in its palatal aspect an incisor wherein the apical portion of the pulp chamber has been properly filled and the main portion drilled and tapped with an A tap and drill. The tap is so set in the tap-chuck as to be a gauge by which the screw-post may be cut as much shorter than the gauge as will let the screw, after it has been placed in the holder (see B) and carried to its place in the root, project as shown in C. D shows a molar in the palatal root of which a B screw has been likewise inserted. It is obvious that large contour fillings may be securely built around screw-posts thus firmly fixed in the roots of such teeth.

Fig. 470.

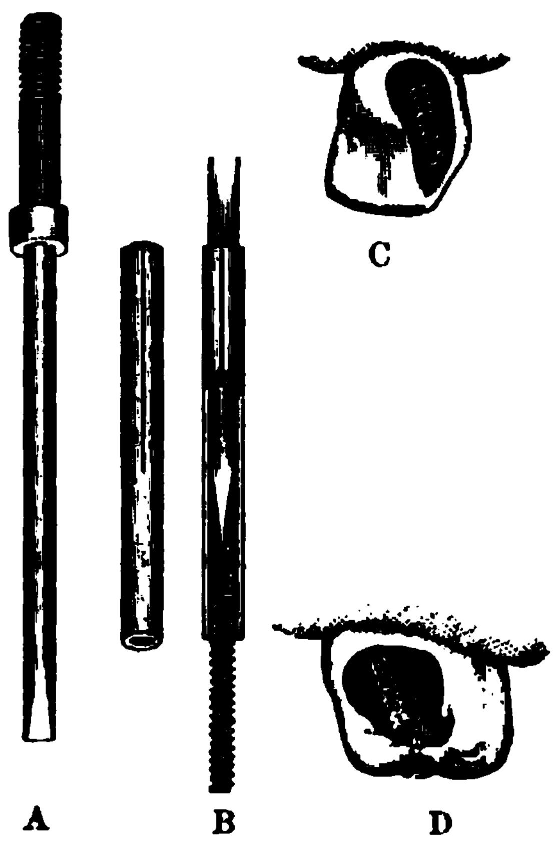


Fig. 471.

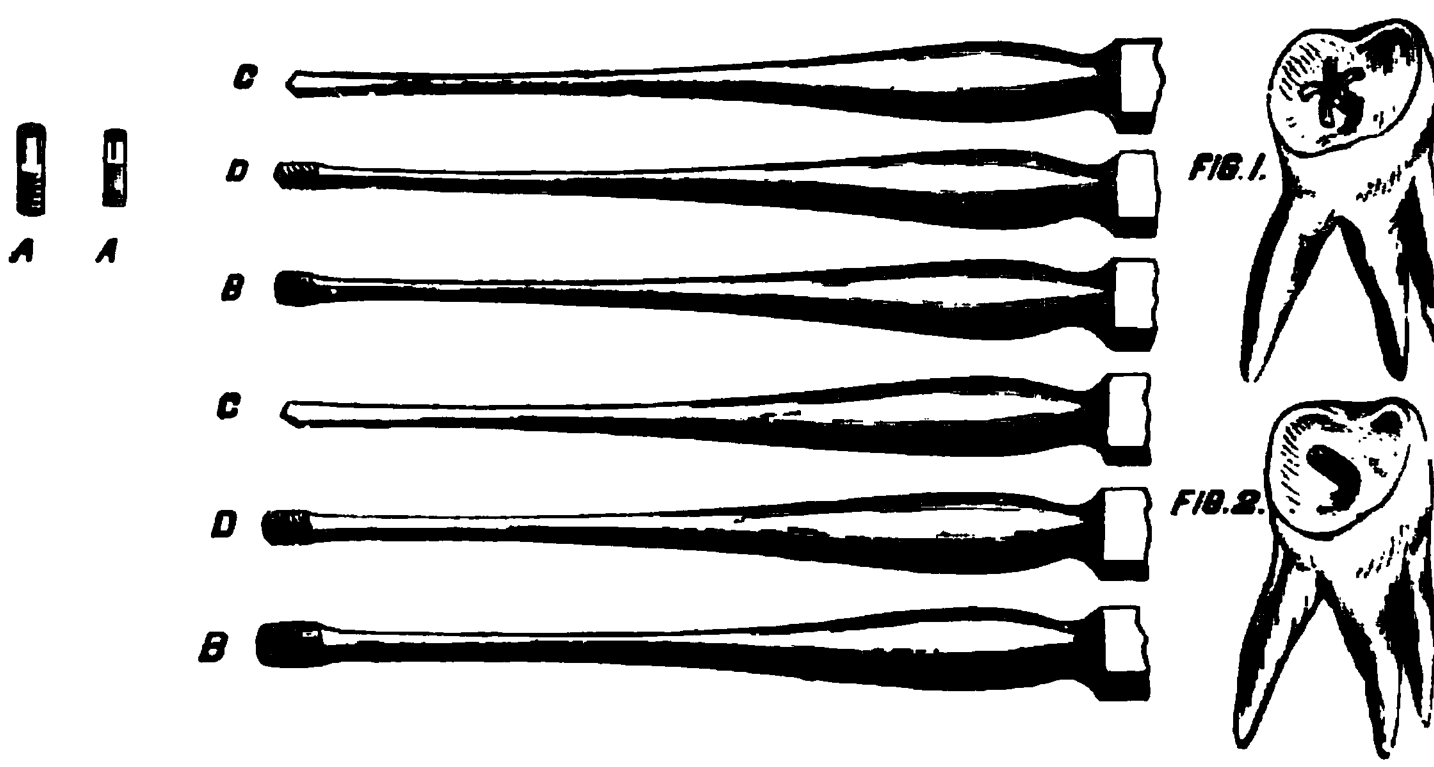


Fig. 471 represents Dr. E. Osmond's screws for securing gold fillings, with the instruments necessary for their introduction.

A A are screws made of 20-carat gold wire, annealed, split about half-way, once or twice, so as to form two or four arms when opened. B is a screw-driver, surrounded by a tube for the purpose of holding the screw and carrying it to its place in the tooth. C is a drill, for the purpose of drilling a hole which is afterward tapped by the tap-screw D.

Figs. 1 and 2 are teeth with large saucer-shaped cavities, such as

FIG. 472.

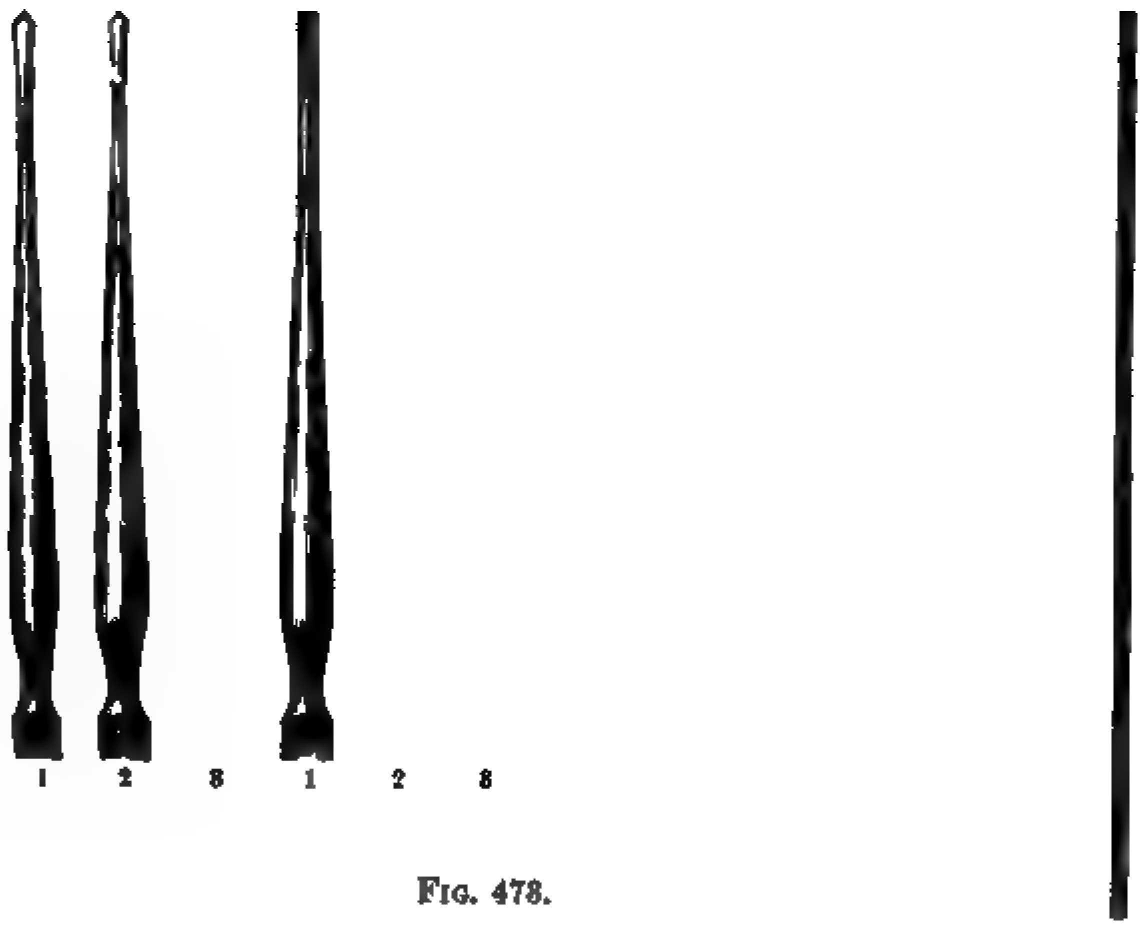
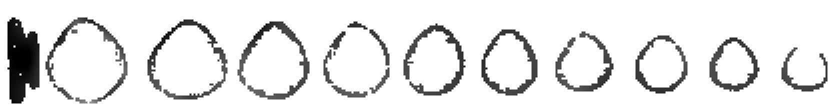
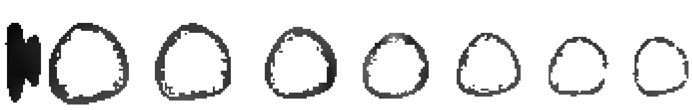


FIG. 473.

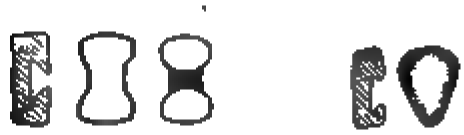
CLASS A.



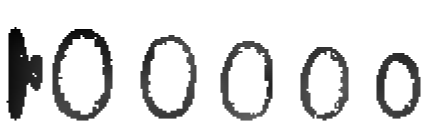
CLASS B.



CLASS C.



CLASS D. CLASS E.



CLASS F.

we very frequently find; but other cases in which these screws are available will readily suggest themselves to the mind of the experienced operator.

Fig. 472 represents the instruments for manipulating what is known as the St. Louis system of retaining screws.

In this set of instruments the drills, taps, and wire fitted for each other bear corresponding numbers, as 1, 2, 3.

The wire-holder is made adjustable to take either size of wire.

The cutting edges of the cutting pliers are formed with two round openings, as shown in the cut. The long wire to be used, if put in one of the openings, can be "nicked" at the proper distance to form the screw while in the wire-holder, so that after having been screwed into place it may readily be broken off without the use of file or pliers in the mouth.

Fig. 474.

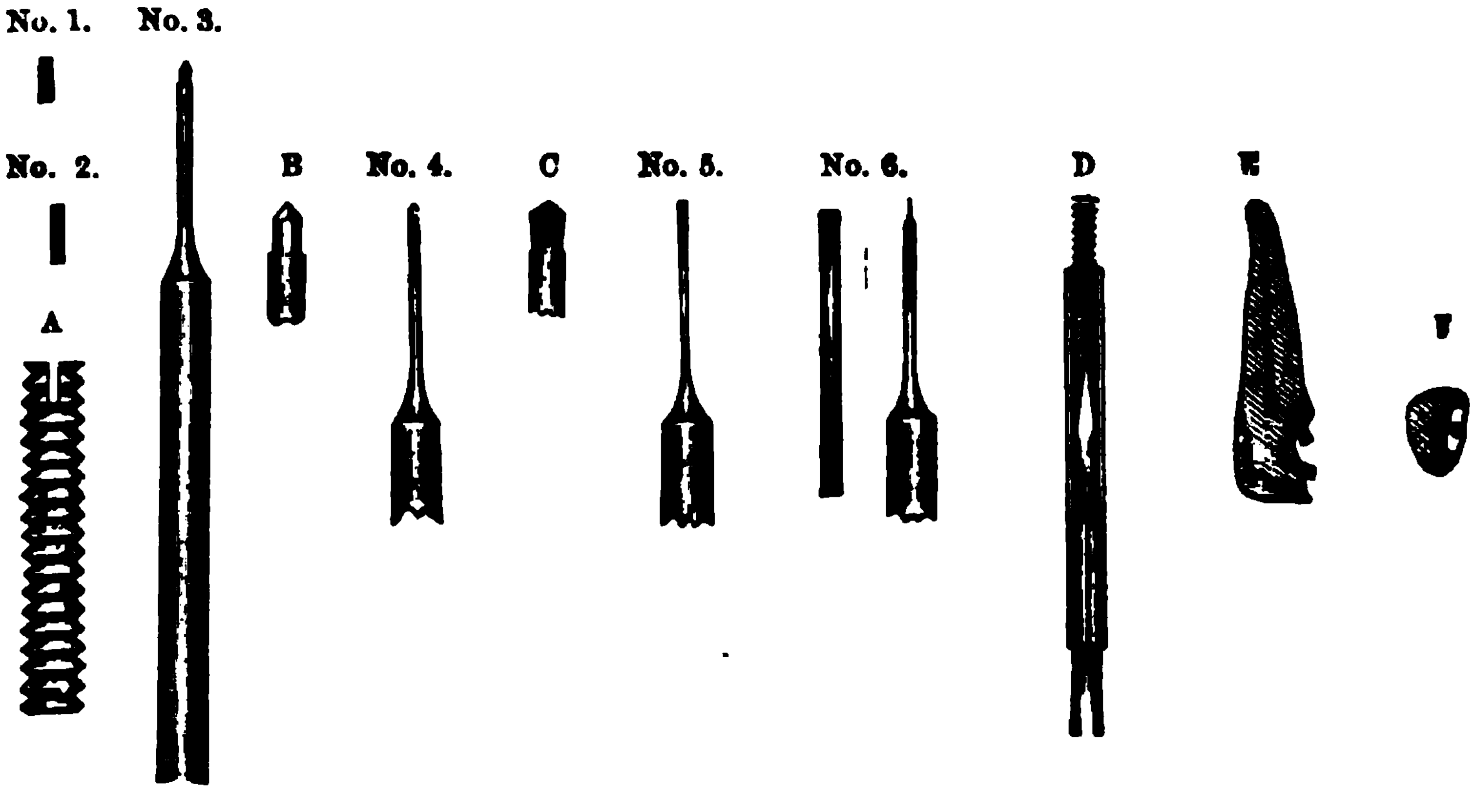


Fig. 474 represents anchor screws, drills, and taps.

Cut No. 1 shows the size of the 18-carat gold anchor screw.

No. 2. Iridio-platinum anchor screw, same diameter, but longer than No. 1.

A. Anchor screw magnified to show thread and slot.

No. 3. The starting or centre drill will form a pit at the exact point desired; but if this point be not at first obtained, the pit centre may be moved laterally while the drill is revolving.

B. Point of centre drill magnified.

No. 4. Limit or anchor drill: will bore only to the depth determined by the limit shoulder,—half the length of screw No. 1.

C. Point of limit or anchor drill magnified.

No. 5. Screw-tap, its diameter being only thirty one-thousandths (.030) of an inch.

No. 6. Screw-driver and sleeve which holds the screw for insertion or removal, as shown magnified at D.

E and F exemplify the anchor screw in gold contouring operations. A drilled and tapped hole to be filled with gold foil serves as a superior retaining point.

FIG. 475.

Under the head of "Contour Work" reference may be made to the use of forms or facings of porcelain, as shown in Fig. 473, for filling cavities of decay.

FIG. 476.

These are to be used in conjunction with oxychloride or oxyphosphate of zinc, gutta-percha, or they may be set in amalgam. Used on an articulating surface, they have the advantage of a hardness at least equal to the most solid metal filling. They may also be used to avoid the display of more noticeable filling material.

For what is commonly called "bridge-work" the reader is referred to the article on "Preparation of a Natural Root and Attachment of an Artificial Crown."

FIG. 477.

The Wilkerson Dental Chair.

Fig. 475 represents Dr. B. J. Bing's method of capping a carious or broken tooth. It consists in properly preparing the walls of the cavity, and taking an impression of it with wax or modeling composition. Dies are thus obtained, upon which gold caps are struck on. Small loops or rings are soldered to the bottom of the caps,

which are secured in the cavities by gutta-percha or oxyphosphate of zinc.

Outfit of Operative Instruments.—Fig. 476 represents a three tray student's case, suitable for an outfit of operative instruments, a set of which may consist of a limited number of instruments, such as pluggers, chisels, scalers, foil carrier and plugger combined, excavators, dental engine instruments, pulp cavity pluggers, drills and extractors, files, syringe, Arkansas stone, foil shears, foil folder, mouth mirror, rubber dam, rubber-dam holder, rubber-dam clamps, rubber-dam clamp forceps, the hand or automatic mallet, chamois skin, orange wood, linen tape, burnisher. The heavy and expensive instruments, such as the dental engine, extracting forceps, and dental chair, are usually furnished by the dental schools. The foregoing illustration represents one of the most popular dental chairs in use at the present time, which combines all of the different movements required by the dental practitioner.

CHAPTER III.

FILLING TEETH OVER EXPOSED PULPS.

THE pulps of the teeth may be exposed by mechanical injuries and caries; the first may occur from falls, blows, the careless excavation of carious cavities by means of the engine-burr or the excavator, while the latter is the result of the destruction and disintegration of the tooth-structure to such a degree as to expose the organ, which becomes irritated as a consequence, and, if the irritation is continued, leads to its suppuration, ulceration, and death. The propriety of filling a tooth after the invasion of the pulp-cavity by caries without first destroying the pulp was for a long time doubted by many practitioners. It was thought that inflammation and suppuration of the pulp must necessarily result from the operation. But Dr. Koecker, who was the first to recommend filling a tooth under such circumstances, cited a number of cases in which he performed the operation successfully. He also expressed the belief that, "on an average, five out of six teeth may be preserved alive and rendered useful for a long while."

Admitting the fact, which is now daily demonstrated, that teeth can be preserved alive after the pulp has become partially or wholly exposed, the question arises: Does the pulp remain in the condition in which it is at the time the operation is performed? It is difficult to conceive either how a vacant space can exist between it and the

filling, or how a foreign body can remain in contact with it with impunity. The late Drs. Harwood, of Boston, and J. H. Foster, of New York, and also Dr. W. H. Dwinelle, held the opinion, from experiments they had made, that it ossifies. That some change of this nature does take place is well known, and the transition is evidently the result of increased vascular action, caused by irritation. Examples of such ossification are met with in teeth in which the crowns have lost a considerable portion of their substance from mechanical or spontaneous abrasion; and it is a beautiful provision of nature to prevent the exposure of these delicate and highly sensitive parts. The same thing sometimes occurs in teeth which have suffered no loss of substance, and is doubtless the result of some constitutional or local cause of irritation.

These facts would seem to justify the conclusion, elsewhere stated, that the pulp of a tooth, when subject for a sufficient length of time to the influence of an irritating agent capable of exciting only very slight irritative action, undergoes ossification; or, rather, is converted into a substance resembling *crusta petrosa*, or what Prof. Owen terms *osteo-dentine*. A tooth which has been filled after the pulp has become exposed is liable, when it fails to undergo this change, either to perish from derangement of its nutritive functions or to become the seat of active inflammation and suppuration. But something more than ossification, or conversion into *osteo-dentine*, of the pulp takes place when a space is left between it and the filling. If this vacant space were not filled up we have reason to believe that the slightest increase of vascular action would, as has been justly remarked by Dr. Elliott, force a portion of the pulp into it; and thus active inflammation would be excited by contact with the sharp angles of the walls of the cavity, and this, as a natural consequence, would be apt to terminate in suppuration; consequently the capping should be adapted as nicely as possible to the exposed surface, leaving no intervening space.

When this reparative process does not take place after the operation, it may be owing either to want or the excess of vascular action in the lining membrane or pulp. A certain amount of increased vascular action seems necessary to the effusion of coagulable lymph, an indispensable requisite; but when it is too great it must of necessity terminate in suppuration. It is obvious, therefore, that the success of the operation must very greatly depend upon the circumstances under which it is performed. If these be unfavorable, all efforts to preserve the vitality of the organ will, in a majority of cases, prove unavailing, however skillful the operator may be in the preparation of the cavity and the introduction of the gold. The health of the patient should be unimpaired, the tooth of a tolerably

good quality, free from pain at the time the operation is performed, and the pulp, peridental membrane and surrounding parts should be in a perfectly healthy condition. The cavity should be of a proper shape for the easy introduction and permanent retention of the filling; and the smaller the point of exposure of the lining membrane, the greater the prospect of success. It is also important that every particle of completely decomposed dentine be removed, and if there be any oozing of blood from the ruptured vessels this must cease before the filling is introduced.

The direct application of any metallic substance to the pulp is, according to the observation of the author, very apt to be followed by inflammation and suppuration of the organ. Some of the vessels of the pulp may be wounded in removing the last layer of decomposed dentine, but the hemorrhage, when no other injury is inflicted, is very slight and sometimes scarcely preceptible; so that the operation of filling need never be delayed more than from three to ten minutes. The application of a small particle of cotton moistened with spirits of camphor, or a solution of tannin, or a little carbolic acid, or tincture of calendula, will usually arrest it.

From the liability to septic influences resulting from the exposure of the pulp, the application of antiseptic agents is generally necessary in such cases, and hence it is a common practice to apply some such remedy as carbolic acid or chloride of zinc, both of which cause cauterization at the point of exposure. Pure carbolic acid is preferred by many, on account of its action being less pronounced and more superficial, for, having little affinity for water, its effect is limited to the surface of the exposed tissue, while chloride of zinc, on the other hand, is more deeply absorbed, and its action is more irritating. Opium, morphia, tannin, etc., exercise a deleterious influence on the pulp-tissues, owing, it is supposed, to the absence of lymphatics. The pure form of carbolic acid is not more irritating than a dilute solution, while at the same time it is more efficient and coagulates the albumen. The method of combining pure oxide of zinc with carbolic acid as a pulp-capping paste, according to the suggestion of Dr. King, appears to be the most rational form of treating exposed pulps, especially when oil of cloves forms one of the ingredients of such a paste, this agent being both antiseptic and anæsthetic, and the combination forming a soft and plastic mass.

The zinc preparations have been extensively employed of late years to cap exposed and partially exposed pulps. The oxychloride of zinc, owing to its irritant action, should never be placed in direct contact with the pulp of the tooth; hence, such substances, in the form of thin disks, as oiled paper, oiled silk, vellum, plati-

num caps, softened quill, and horn have been used as interposing materials.

It is the practice of some to coat the surface of such disks in contact with the pulp with a solution of gutta-percha and chloroform, which acts as a non-conducting substance and is tolerated by the sensitive organ, owing to its anodyne and protective properties. The interposing substance may be held in place within the cavity by a delicate excavator or nerve instrument, and the oxychloride, of thin consistency, flowed over it, when the remaining portion of the cavity can be filled with the same material in the form of a thicker paste. A portion of this material is afterward removed, for the accommodation of a more permanent filling. Caps of tin of a thickness of No. 28, and of platinum No. 30, the concave surfaces filled with the paste above referred to or with a solution of gutta-percha and chloroform, and carefully applied over the point of exposure, will often prove serviceable in restoring the pulp to a normal condition. It is suggested that such caps be inserted edgewise, in order to prevent the direct pressure of the air or the paste on the sensitive organ. Over the metal cap a temporary filling is introduced—one which requires little force for its introduction and of low conductivity. For such purposes the zinc preparations are commonly employed, although some prefer gutta-percha, tin or amalgam. The zinc preparations when employed for such temporary fillings should not be neglected, owing to their liability to disintegrate near the margin of the gum. Gutta-percha, in the form of Hill's stopping, is also used with success as a capping material, a very thin disk, which becomes plastic at a low temperature, being first applied, so that the effect of the heat may be reduced to a minimum. Asbestos, either alone or enclosed between layers of gold or tin foil, has also been employed as a capping, concave disks being formed when metal is used in combination with the asbestos, the inner surfaces of which are coated with the solution of gutta-percha and chloroform. Thin card-board paper, in the form of caps saturated with carbolic acid, has also been employed as an interposing substance between the point of exposure and a filling of the zinc preparation. Dr. W. C. Barrett has been successful in capping exposed pulps with the lactophosphate of lime, which is applied as an immediate cover to the exposed tissue, and which is prepared as follows: on a piece of glass or porcelain is placed a drop of Merck's lactic acid, to which as much magma phosphate is added as it will digest; it is then reduced to the proper consistency by adding the dry precipitated phosphate. The magma phosphate must be kept under water. It has been found that the lactophosphate of lime, prepared as above, is very congenial to the pulp.

Dr. King's method of capping exposed pulps is as follows: A temporary filling of the oxychloride or the oxyphosphate of zinc is placed over the capping, the rubber dam being applied in all cases previous to the excavation of the crown cavity. Pure wood creosote is mixed with pure oxide of zinc, to the consistency of cream, when it is flowed over the exposed surface. Oxychloride or oxyphosphate of zinc, mixed to the same consistency, is placed over the capping of the creosote and oxide of zinc and allowed to remain for a few days, when a portion of the temporary filling is removed and a more durable one inserted.

Although bathing the exposed surface of the pulp with pure carbolic acid is practiced by many prominent dental practitioners, others contend that the escharotic action of the agent may prove injurious, and hence use either a diluted form, or the pure crystallized carbolic acid rendered fluid by a small quantity of chloroform; others assert that the results desired cannot be effected by a dilute solution of carbolic acid, owing to its greater affinity for water allowing it to be absorbed to a much greater degree, and causing more irritation and less coagulation than the pure form. It is very essential, in the treatment of cases of exposure of the pulp, that a due regard be paid to the condition of the organ, and the difference between normal and abnormal sensitiveness determined. If it is a case of simple exposure, after carefully preparing the crown cavity and the margin of the opening leading to the pulp, after syringing with tepid water, all moisture should be carefully removed, and a drop of the solution of gutta-percha dissolved in chloroform applied on the point of a delicate instrument (some prefer dilute tincture of aconite or a thin coating of glycerine or collodion), and the cavity filled temporarily with wax or cotton, the tooth remaining at rest for a few days and protected from irritation.

When everything has progressed favorably for such a period the operation of capping may be performed. Should the pulp be irritable or the seat of acute pain when first examined, the cavity should be syringed out with tepid water containing a sufficient quantity of carbonate of soda to render the solution slightly alkaline. Such an application will relieve the pain, even if it is acute. The application of lead water is often useful for the same purpose, or the dilute tincture of aconite, or a solution of the sulphate of atropine.

Professor James H. Harris recommends the following method of treating teeth with exposed pulps: "First remove all decomposed dentine, for if any dentine in such a condition is allowed to remain, the progress of decay will continue and cause inflammation of the pulp, finally resulting in its destruction. Even if the carious portion *is* entirely removed and the pulp *not directly exposed*, we still

need not be too confident of the ultimate preservation of the vitality of the tooth, for the *probability* is that the dentinal fibrillæ die in advance of the actual *decomposition* of the tooth substance, and hence, before the decay has actually reached the pulp, this organ may have assumed a condition from which recovery is impossible. Still, however, every attempt should be made to preserve the vitality of the pulps of the teeth, and with this object in view, having removed all of the decay, should any hemorrhage occur it may be arrested with spirits of camphor or with camphor and tincture of opium. The entire crown cavity should now be carefully filled with a *temporary filling* of Hill's stopping, avoiding undue pressure upon the pulp. The first piece of the Hill's stopping may be more safely adapted by first moistening it with chloroform.

"This temporary filling should be removed from time to time, as may be necessary, during a period of from one to five years, according to the health of the patient, extent of exposure, etc. With this treatment the reparative process will more readily go on, and when the pulp is found to have become protected by a layer of osteo-dentine a permanent metallic filling may be inserted.

"As a further precaution against danger to the pulp, a layer of Hill's stopping or of oxyphosphate of zinc may be placed in the bottom of the cavity and the permanent filling inserted over this. Sometimes, when the exposure is quite large, it will be found well to cap the pulp with a *thin mixture* of oxyphosphate of zinc, as this material can be more readily adapted to the exposed pulp without danger of producing undue pressure. But even when this method is pursued it is best to first coat the exposed surface of the pulp with a solution of gutta-percha and chloroform, in order to protect it from the slightly irritant effect of the oxyphosphate. The oxyphosphate first introduced should be mixed thin and allowed to harden, when the remainder of the cavity should be filled with the same material mixed stiffer, especially when the cavity involves the grinding surface, where a portion of the filling is subjected to the friction of mastication. Sometimes, in large grinding surface cavities, after capping and filling the cavity two-thirds full of Hill's stopping or oxyphosphate, the filling may be finished with amalgam, which is permitted to remain as a test-filling for from three to six months, when, if no symptoms of pulpitis manifest themselves, such as paroxysms of pain caused by heat and cold, and gradually becoming constant, a portion of the temporary filling (about one-third) may be removed and the cavity filled with amalgam, which is allowed to remain, as before stated, from one to five years. Then the amalgam may be removed, and, if necessary for the support of the gold to be substituted, a small portion of the Hill's stopping or

the oxyphosphate, and a gold filling inserted. In removing the temporary filling, preparatory to inserting a gold filling, the condition of the dentine should be carefully noted—whether it is normally sensitive or not, as the pulps of teeth often die from chronic inflammation without pain to the patient, in which case the dentine would be devoid of sensitiveness. Ossification of a pulp renders the dentine painless. During the removal of a portion of the temporary filling, should the dentine be found not sensitive, the operation of removing the temporary filling should be continued until the cause of such want of sensation be ascertained, whether due to the death of the pulp or its ossification.

"In performing the operation of 'capping' the rubber dam should be applied if possible.

"In the treatment of cases of exposure of the pulp a careful record should always be kept, as it is impossible to remember the peculiarities of each case extending through a long period of treatment."

The following method of treating exposed pulps was recommended by the late Dr. M. H. Webb:—

"If irritation of the pulp be caused by the acid condition concomitant with the disintegration process, it should subside after tepid salt water has been injected, and the parts thus cleansed, the softer portions of carious dentine removed, and bicarbonate of soda, potash, or ammonia applied. Should the exposed or nearly exposed tissue be impinged upon by the carious dentine or a foreign substance which has been forced during mastication upon it, and thus obstruct the nutrient currents, the irritation thus induced should cease after the removal of the agent which causes the obstruction. When the pain has ceased the parts should be dried with Japanese bibulous paper; an application of carbolic acid should be made to disintegrated dentine which may yet remain and coagulate the protoplasm at the exposed part of the pulp, if there be such exposure. After this has been done a cap of note-paper or fine card-board should be placed over the nearly or fully exposed part of the pulp, so that it be not pressed upon during the insertion of gutta-percha; all of which is but preparatory treatment. After the cavity has been thus cleansed, the pulp protected, and ease secured, the rubber dam should be applied, the temporary filling removed, light reflected upon the parts by a mouth mirror, and all decalcified tissue cut away, excepting the discolored or partially disintegrated dentine, which may yet cover the pulp, such a protection being very much better than an artificial one. When all this shall have been done, warm air should be used to drive off the moisture (as well as to expel the chippings) which may yet be in the cavity and on the

discolored dentine; then the latter should be moistened with carbolic acid or a saturated solution of salicylic acid in alcohol. Where the pulp is nearly or partly exposed it is best to flow carbolic acid over the part and, before evaporation follows, take some of the oxide of zinc on the end of a small spatula, place it at the entrance to the cavity, and, with a puff of warm air, spread it over and about the exposure, there to be retained by the deliquescent carbolic acid. After this has been done one of the preparations of oxychloride of zinc (the oxyphosphate may now answer better) should be mixed to the consistency of thick cream and made to flow down one side of the cavity, over the layer of oxide of zinc and carbolic acid (or pure wood creosote), and along the whole surface of the dentine, and to the outer margin of the enamel. The rubber dam ought not to be removed for about an hour after the oxychloride (or oxyphosphate) of zinc has been placed in the cavity, because a more perfect crystallization of the cement takes place when it is dry. These cases should be kept in this condition for some time (in some cases a year or more) before the permanent filling is inserted, although, under favorable conditions, the operation may be proceeded with immediately or very soon after the oxychloride of zinc has crystallized; but whenever this operation is to be performed only enough of the cement should be removed to secure proper and sufficient anchorage for the gold."

In using creosote or carbolic acid in combination with the oxide of zinc, the excess of the fluid can be removed with spunk, thus leaving a thin layer only, to prevent the pulp from being brought in direct contact with the zinc preparation.

As the oxyphosphate and oxychloride are not non-conductors, it has been suggested to place a thin layer of gutta-percha over them, to protect the tooth from thermal changes.

In cases of long exposure it has been recommended to wash out the cavity with a warm solution of salt and water, for its sedative effect, or of carbonate of soda; then to apply creosote on a pledget of cotton, over which a temporary filling of Hill's stopping is placed, to remain for one or two days; then to remove the temporary filling and, if no pain has been experienced, to cap the pulp, as in a case of more recent exposure.

Where it is desirable to cap the pulps of the temporary teeth, and the oxyphosphate of zinc cannot be employed, owing to its irritating action on the sensitive tooth structure, a convex cap of platinum, the concavity of which is filled with the solution of gutta-percha and chloroform, may be applied in such a manner as to avoid pressure, and a Hill's stopping filling inserted over the cap.

The treatment just described refers to pulps free from disease, the

condition being primary irritation from exposure and not inflammation from long-continued irritation. In the great majority of the latter cases attempts at preservation prove failures, and when persisted in may prevent any successful subsequent treatment following the extirpation of the pulp. Hence it is necessary to accurately determine the condition of the pulp, when exposed, by a careful examination before treatment is commenced. When the patient possesses a healthy constitution and correct local conditions are present, efforts for the preservation of pulps in more or less unhealthy conditions may be instituted. For example, if effusion of serum or lymph is present the tincture of aconite should be applied to the pulp and also to the gum about the neck and root of the tooth, after which the application of pure carbolic acid to the exposed surface of the pulp, to produce coagulation, is indicated. If such treatment arrests the exudation, which may be determined by drying the parts, then the treatment for a simple exposure of the pulp may be at once instituted, or oxide of zinc made into a paste with water may be applied and the cavity in the crown of the tooth filled with a temporary material. Should the exudation continue the same paste may be applied to the exposed surface of the pulp, but a loosely introduced pellet of cotton saturated with sandarac should be substituted for the temporary filling, so that the fluids of the mouth may be excluded, but the cavity should not be closed so tightly as to cause trouble by the retention and accumulation of the effusion. When the vessels of the pulp are engorged, depletion by means of an incision, after the application of equal parts of oil of cloves and chloroform, may be made and the pulp be capped by the paste before referred to, over which a pellet of cotton saturated with sandarac may be placed. Such a dressing is allowed to remain for several days, when, if everything is favorable, the permanent capping of the pulp may be made. For purulent discharges from the pulp, after the removal of the irritation, the treatment consists in the application of a mild escharotic in the form of a solution of chloride of zinc, grs. xxx, water ℥j, for several minutes, after which repeated injections of tepid water should be made and the cavity exposed to the saliva to free the eschar from the chloride of zinc. The subsequent treatment is the same as that described for effusions of serum and lymph. When the pulp is accidentally exposed, as in cases of injury resulting in the fracture of the crown of the tooth or by careless excavating of a cavity of decay, the treatment consists in the immediate application of tincture of calendula diluted with water and the capping of the exposed surface of the pulp with a cap of gold, tin, or platinum containing the

paste composed of oxide of zinc, carbolic acid, and oil of cloves, taking the precaution to avoid all compression. The case should be carefully watched afterward, and if there is undue sensitiveness to cold, which is usually the indication of further trouble, the gum about the affected tooth should be bathed with a solution composed of tincture of aconite, ℨij, and chloroform, ℨj. Several applications may be required, although frequently but one is necessary. Another application for the same condition or in case the former one is not effective, consists of tincture of iodine, fℨij; tincture of aconite, fℨj, and chloroform, fℨj.

CHAPTER IV.

FILLING PULP CHAMBERS AND CANALS OF TEETH.

THIS operation has now become very common, and is practiced by the most skillful dentists in America and Europe, although its propriety was for a long time doubted by many. The objection to the practice was founded upon the supposition that in proportion as the vitality of the tooth is lessened it becomes obnoxious to the surrounding living parts. But more recent experiments have shown that it is not a necessary consequence.

Drs. Maynard and Baker were the first to show that most of the morbid phenomena resulting from the presence of a tooth in the mouth after the destruction of the pulp arose from the irritation produced by the matter contained in the pulp chamber and canal of the root. To prevent their occurrence, therefore, they proposed filling both chamber and canal in such a manner as completely to exclude everything else. The accumulation of purulent matter being prevented here, its secretion at the extremity of the root will, in a majority of cases, either cease altogether or go on no faster than it is reabsorbed, as has been shown by repeated experiments Thus it would seem that the amount of vitality which a tooth derives from the investing membrane is sufficient, ordinarily, to prevent it from exerting any apparent morbid action upon the surrounding parts.

Although it is desirable that the operation should be performed before any diseased action has been set up at the extremity of the root, much advantage may sometimes be derived from it, even after alveolar abscess has actually occurred, as great benefit often results from cleansing and filling the roots of teeth which had given rise to abscess.

The application of carbolic acid or creosote to the inner walls of the sac, introduced through the canal in the root previously to filling, is one of the most certain means of cure. The latter agent was first recommended by Dr. C. W. Ballard. Either agent can be introduced, on the end of a thread of floss silk, to the sac at the extremity of the root, through the pulp-cavity and canal of the root, previously freed of all extraneous matter. Another mode of applying these agents to the ulcerated inner surface of the sac, first suggested by Dr. F. H. Badger, is by injection with a syringe, the opening in the crown being first closed with a filling of Hill's stopping, with a perforation large enough to admit the end of the tube of the instrument. Creosote has also been used in the form of a strong alcoholic solution, say one drachm of creosote to an ounce of alcohol. This, being forcibly injected into the tooth, passes through the sac at the end of the root and escapes through the fistulous opening in the gum, where it is caught on a piece of soft sponge or a few folds of bibulous paper. There are many cases in which there is simply a slight morbid secretion that escapes through the tooth without any discharge from the gums. The means most efficacious in arresting this are the same as those recommended for the treatment of alveolar abscess; the escharotic agent in this case should be introduced in the manner as first described.

Dr. E. J. Dunning stated, in a letter to the author, in 1850, that he had been for several years, and was then, constantly in the habit of filling the roots of teeth after destroying their pulps, and also of cleansing and filling the roots of the teeth which had previously lost the entire pulp and become more or less diseased. He also stated that very few cases had occurred in his practice where suppuration had supervened, rendering the removal of the tooth necessary. In proof of the correctness of this opinion, he has furnished the author with the following details of a case which came under his observation:—

"A gentleman from the South called immediately after his arrival in this city, and stated that during his passage in the steamer he had been suffering intensely from pain in a first superior molar. On examination I found the tooth thoroughly injected with red blood and the periosteum highly inflamed and considerably thickened, though there was no swelling of the gum. A small cavity in the posterior approximal surface had been filled with gold a day or two before sailing. In preparing the cavity for filling arsenic had been used to allay sensibility. In most cases I should have advised the removal of the tooth, for the symptoms were very unfavorable to any operation for its preservation. But as the mouth was other-

wise perfectly healthy, the arch unbroken, the cavity in the tooth very small, and the patient extremely anxious to preserve it, I determined to make the trial.

"On examining the cavity carefully I found that the nerve had never been exposed; the arsenic had acted upon it through the circulation, and had thus produced this severe inflammation. Having removed the layer of sound bone that covered the nerve, and finding it quite sensitive, I made an application of an exceedingly small quantity of a mixture of arsenic, morphine, and creosote, and covered it with a metallic cap or arch to prevent pressure, followed by a loose filling of tin-foil. The pain and much of the soreness was immediately relieved.

"Saw the patient again on the fourth day; found the soreness entirely gone; had suffered no pain since the application was made; injection remained the same. Found the part of the pulp contained in the central cavity entirely insensible; removed it, finding the portion in the roots still sensitive, made the same application at the entrance of each canal and filled the cavity again with tin. At this sitting ventured to file the tooth so as to increase the separation between it and the second molar. The filed surface showed the injection beautifully, the bone appearing a bright red, and the line at the junction with the enamel very distinct. In three or four days saw the patient again, and to my surprise and delight found that the injection had entirely disappeared, and the tooth almost as perfect in color as any of its neighbors. The nerve was then removed from the roots and its place filled with gold, and at a subsequent sitting the external cavity was filled. As three months have elapsed since the operation was performed without hearing from it, I conclude that it is thus far successful."

The injection of the tooth from the vessels of the pulp is of frequent occurrence in teeth to which arsenic is applied for the purpose of merely destroying the sensibility of the dentine. At the first meeting of the American Society of Dental Surgeons, Dr. Hayden mentioned a case that had a short time before fallen under his observation, and several others were cited by the author at the same time. Afterward he met with numerous cases in which this had occurred. It is doubtless the result of increased vascular action, excited in the pulp by the action of the arsenic, and it proves that the blood globules become disorganized and the coloring matter escapes into the tubuli of the dentine. It occurs, however, much more frequently in the teeth of young than in those of old persons.

Treatment Preparatory to Filling the Canals of Teeth.—The following is the method of treatment, preparatory to filling the root, pursued

by Prof. Gorgas: "I remove carefully all disorganized pulp and decomposed dentine; also all discolored dentine, provided it does not weaken the walls of the cavity. Then, syringing out all loose particles of the *débris* with tepid water, I dry the canal to the apex of the root with floss silk, being careful to leave an end projecting, so as to permit its easy removal. Several such pieces being used, a shorter piece is then saturated with pure wood creosote or carbolic acid and passed to the end of the canal, leaving a slight projecting piece in the crown-cavity, so that it may be seized with pliers when it is to be removed.

"I then introduce into the crown-cavity a temporary filling of Hill's stopping, gutta-percha, or the zinc preparations. In some cases where the effusion is considerable, and its retention causes discomfort, the temporary filling should consist of cotton saturated with sandarac, loosely introduced, so that it may be readily removed by the patient if necessary. In twenty-four hours the canal is examined, and the disinfecting agent renewed if necessary. When not the slightest odor of purulent secretion is perceptible, I then apply on the floss silk carbolic acid mixed with a little chloroform, replace the filling, and wait for several days.

"If at the end of this time there is no trace of diseased action I fill the canal with gold; then wait a few days until all chance of irritation from the pressure used in the operation has passed away, and then complete the filling. But not unfrequently it is necessary to repeat this course of treatment several times. In one case two months were required before the tooth was in a condition to warrant me in filling it.

"In some cases I deem it prudent to insert a filling of 'Hill's stopping' for several months, especially when there is the slightest doubt of the arrest of the disease; for the gold once introduced into the canal it is exceedingly tedious and difficult to remove it. Disease on the *outside* of the extremity of the root may be controlled by creosote, carbolic acid, or nitrate of silver, applied through the fistulous or an artificial opening in the alveolus. (See Alveolar Abscess.)

"Chloride of zinc may be used instead of creosote when the smell of the latter is particularly repulsive to the patient; also, a combination of carbolic acid or creosote and iodine, as Dr. Leech's formula, which is composed of iodine (crystals), ʒj; carbolic acid (crystals), ʒj; alcohol, fʒij, applied on a pledget of cotton or on floss silk; or a saturated solution of iodoform and ether; or eucalyptus combined with iodoform, as Dr. Parmele's formula, which is

composed of eucalyptus oil, ʒj; iodoform, gr. x; water, ℥j; all of which are excellent antiseptics. Any trace of the living pulp should

FIG. 478.

be treated with some devitalizing agent, which may be introduced upon floss silk before commencing the antiseptic treatment."

FIG. 479.

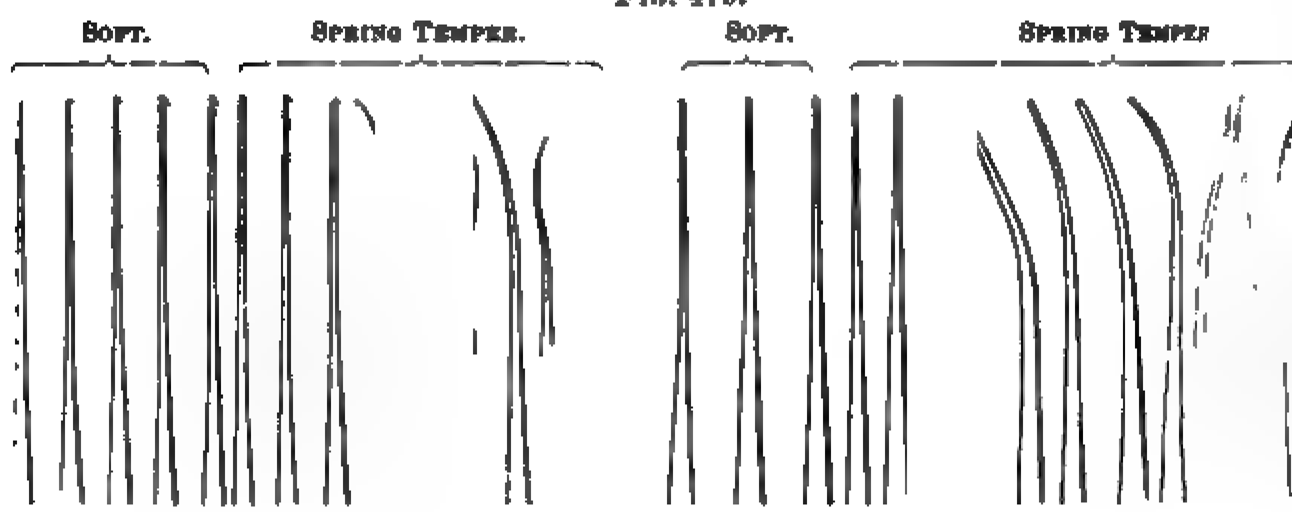
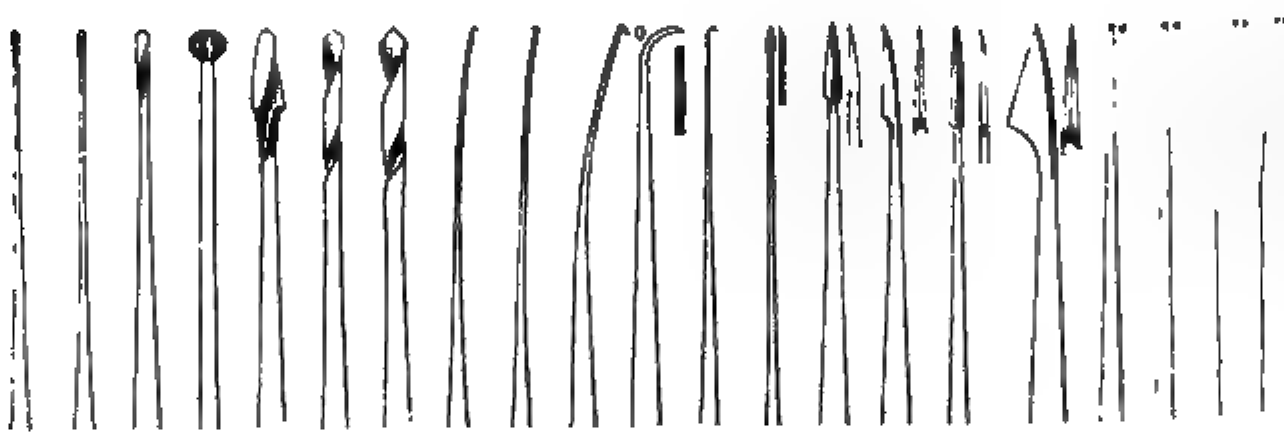


FIG. 480.



The immediate filling of the root-canal in such cases is also recommended. (See Alveolar Abscess.)

Fig. 478 represents iridio-platinum nerve broaches for extracting dead pulps of teeth and for introducing into the pulp-canal medicinal agents in the treatment of diseased teeth. They do not corrode

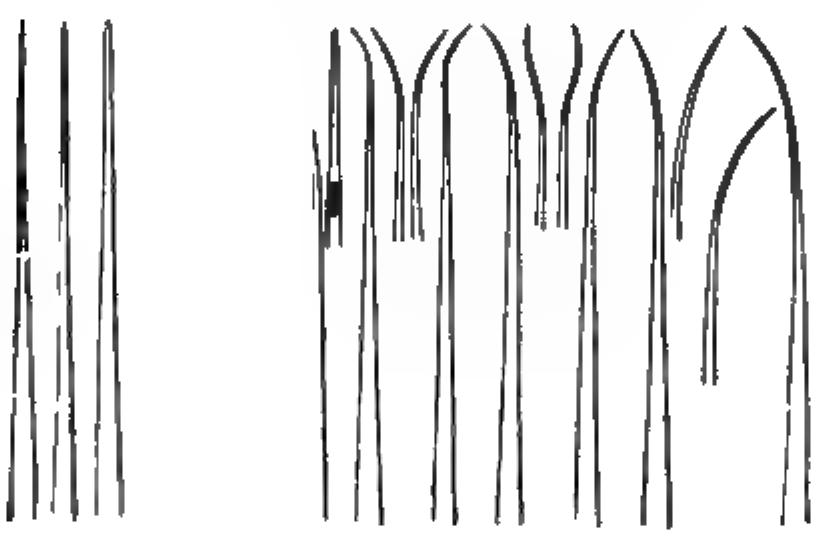
when exposed to moisture, acids, iodine, etc., and can be cleansed perfectly by heating to redness in the flame of a spirit lamp.

Fig. 479 represents a set of Dr. B. F. Arrington's devitalized nerve extractors and canal pluggers, of drawn and spring temper.

Filling Pulp Chambers and Canals of Teeth.—For filling pulp canals very nice instruments may be made from piano wire filed to any desired size and fitted into suitable handles, such as are represented by Fig. 481. This wire is very tough and elastic. The gold used for filling pulp canals should be non-cohesive and folded into a very light ribbon, and this cut into square pieces, which should be placed upon a piece of folded chamois skin and carried to the pulp canal by means of the nerve-canal plugger point. Piece after piece of the gold is carefully introduced to the apex or upper extremity of the root until the entire canal is filled. Strips of heavy gold foil conveyed to the apex of the canal in a similar manner, or by mallet force, are also employed for filling root canals. Malleting the gold into the canals is also preferred by many to pressure with the hand, as percussion causes no

FIG. 481.

FIG. 482.

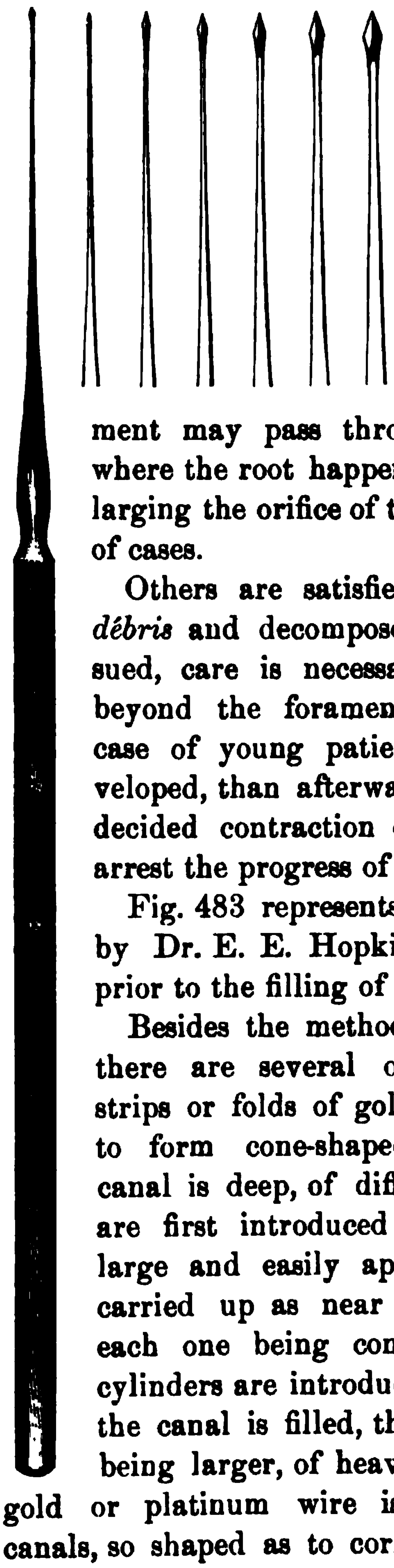


deflection of the instrument such as may occur under pressure with delicate canal pluggers. The cavity in the crown is then filled in the usual manner.

Fig. 480 represents a set of nerve instruments contrived by Dr. Corydon Palmer for forming the canals in the roots of the teeth.

Fig. 482 represents Dr. Hunter's set of pulp-canal pluggers, some of which are of drawn and others of spring temper.

FIG. 483.



After the cavity of decay in the crown has been properly prepared by means of the instruments represented in Fig. 480, the pulp chamber can be excavated and so shaped as to assist in the retention of the gold. Some operators drill out these canals and thus give them the same diameter from their orifice at the pulp chamber to the apex of the root, but this is considered by many to be an unnecessary as well as dangerous operation, as the instrument may pass through the side of the root, particularly where the root happens to be curved. Reaming out and enlarging the orifice of the canal will be sufficient in the majority of cases.

Others are satisfied with cleansing them perfectly of all *débris* and decomposed dentine. Whichever method is pursued, care is necessary that the instrument is not passed beyond the foramen, which is more liable to occur in the case of young patients, when the teeth are not fully developed, than afterward; for then there is generally such a decided contraction of the root canal near the apex as to arrest the progress of the instrument.

Fig. 483 represents a set of nerve-canal reamers, devised by Dr. E. E. Hopkins for the enlargement of the canals prior to the filling of the same.

Besides the method of filling the roots described above, there are several others, one of which consists in rolling strips or folds of gold on a fine broach in such a manner as to form cone-shaped cylinders, somewhat longer than the canal is deep, of different sizes and density. The soft rolls are first introduced on a smooth broach, or, if the canal is large and easily approached, by means of the pliers, and carried up as near to the apex of the root as is possible, each one being condensed as it is introduced. Successive cylinders are introduced in this manner and condensed until the canal is filled, the last ones which complete the filling being larger, of heavier gold, and more densely rolled. Pure gold or platinum wire is sometimes employed for filling these canals, so shaped as to correspond in size and taper with the cavity.

These wires should be coated with gutta-percha or oxyphosphate of zinc before introducing them.

It sometimes happens that the canals in the buccal roots of the superior molars are so small as to preclude the introduction even of a small-sized bristle. In cases of this kind it is impossible to fill them, and fortunately, from their small size, they cannot serve as reservoirs for the accumulation of morbid matter. Such canals, however, should be thoroughly disinfected before the larger ones are filled. The canal in the palatine root is always much larger than in either of the buccal roots, and in a majority of the cases is filled with comparative ease. Although gold and tin are the only metals suitable for filling root canals, yet some non-metallic substances have answered well when employed for this purpose, such as Hill's stopping and the oxyphosphates. Gold may be employed for filling the space of one-third of the canal from the apex, and the remaining portion may be filled with oxychloride or oxyphosphate of zinc. For bleaching teeth which have become discolored from loss of vitality, the reader is referred to the chapter on "Necrosis."

In the treatment of the canals of devitalized teeth, if there is a secretion of liquid (protoplasm) through the foramen into the pulp canal, bibulous paper or absorbent cotton may be employed for drying the canal, when chloride of zinc in a deliquesced form should be introduced in cotton wound about a broach, which will coagulate the fluid emanating from the elements of the tissues about the apex of the root, and the canal can at once be permanently filled. A putrescent pulp remaining in the root canals gives rise to the formation of sulphuretted and phosphoretted hydrogen gas from the disintegrating tissue, which, with the particles of such tissue and the foreign matter forced through the foramen, causes irritation of the tissues surrounding the apex of the root. The secretion of pus will continue as long as the putrescent matter remains in the canal and the mephitic gas evolves from it through the apical foramen. And relief is experienced only when the suppurating surface is destroyed and a normal action brought about by the removal of the irritating matter and the action of an escharotic, or disinfectant, such as carbolic acid or creosote, iodoform, eucalyptus, etc., assisted by injections of warm water as a cleansing process.

The method of "immediate root-filling" is described by Dr. Frank W. Low as follows:—

"The instruments best adapted for general use, especially in the deeper portions of the pulp canals, are Donaldson's spring-tempered pulp canal cleansers. First, because, if they penetrate a

root in which is present a sloughing and partly disorganized filament of the pulp, they seem to cause less pain than barbed broaches, and are more likely to so engage the fibre as to bring it away entire. Second, in the absence of any sensitive filaments the debris is removed rapidly, engaging itself in the screw threads of the instrument its entire length, from which it can be readily removed when withdrawn by brushing with an ordinary tooth-brush. Third, because if it is found, when screwed into the canal, that it will not *strip* out—thus bringing its load—it can be safely and easily disengaged by turning to the left, as you would remove any other screw-threaded instrument. Fourth, because the worn-out instruments are of such fine temper that they can be ground on the lathe corundum wheel into four or five-sided broaches, and as such can be utilized to wrap minute shreds of absorbent cotton upon for the final drying process before the gutta-percha cones are introduced. Several of these can be wound, even by an inexperienced assistant, and thus be ready at once for rapid successive introduction just preceding that of the cones.

Fig. 484.

"The penetration of canals will be accelerated by frequent injection of peroxide of hydrogen, because of the expulsions of their contents, incident to the effervescence of this com-

pound, as well as its chemical combination with and consequent softening of the products of infection present.

"When the instruments have at length penetrated the apex of the root—of which fact you may safely trust the patient to make you aware—it will often be found upon injecting the peroxide solution once more that effervescence (which perhaps just before had nearly or quite ceased) will again manifest the presence of septic matter; this, however, is caused by the pus so often confined in the 'apical space,' and any further penetration of the broach is contraindicated. It is not sufficient merely to inject in order to obtain the full benefit of the peroxide in this new territory of infection, but the plunger of the syringe should be worked with a rapid churning motion for several seconds, while the nozzle of the instrument remains as deeply fixed as possible in the pulp canal under treatment, for by this reciprocating motion of the plunger the fluid is forced beyond the apex of the root and into the infected territory, and thoroughly mixed with any pus which may then be present.

"The instrument best adapted for the purpose of thus injecting the peroxide of hydrogen is the Lewis abscess syringe (Fig. 484). The advantages to be derived from its use are that it can be operated with one hand and the pumping or churning motion above mentioned be easily accomplished. The capacity of the syringe is so small that the injecting process is prevented from becoming a sloppy one, while at the same time the fit of the plunger is so perfect that the injection is accomplished with considerable force.

"When effervescence again ceases—which will be indicated if, upon removal with cotton or spunk of all the "lather" previously made, it is found that further injection produces only such bubbles as may be expected from the confinement of particles of air in any liquid—the canal should be wiped out and an injection of the $\frac{1}{1000}$ bichloride of mercury solution substituted. It is just possible that the use of the bichloride solution might be dispensed with; but it is the most powerful known germicide, and besides it is just sufficiently irritant to cause the inner walls of the abscess—if one be present—when collapsed, to become obliterated by adhesion.

"To facilitate this collapse of the walls of the pus sac, the syringe again comes into use as an aspirator. The use of the dry hot air current is next indicated, and last of all the little broaches wound with cotton shreds. Several of these latter should be used, even though the first one withdrawn appears to be dry, because they are the most perfect exhaust plungers after all. Following their use, the canals should be quickly sealed with gutta-percha cones dipped in a thin chloro-percha solution to facilitate their deep penetration

into the canal and at once to varnish them tight to its walls. A moment's wait—which usually is gratefully accepted both by operator and patient—is now advisable in order that the chloroform of chloro-percha, which, as the cone descends into the cavity of the canal, will be found to have regurgitated, may have an opportunity to evaporate. After wiping this off with spunk or cotton, the cone will be found very soon to be dry, and then it can be condensed a trifle, after which, if the material to be used be other than gold, the crown filling can safely be made at once.

"If gold is to be the material used, the operation had better be deferred for a few days, lest the impact of the plugger should cause acute inflammation of the irritable peridental membrane. The writer had an unpleasant experience which taught him the necessity of this precaution, and yet he has been obliged on several occasions since to resort to immediate crown- as well as root-filling for patients residing out of town, and as yet has heard no report of resulting pericementitis."

CHAPTER V.

EXTRACTION OF TEETH.

THERE are few operations in surgery that excite stronger feelings of dread, and to which most persons submit with more reluctance, than the extraction of a tooth. Many endure the torture of toothache for weeks, and even months, rather than undergo the operation; and, indeed, when we take into consideration the frequent accidents occurring in its performance by awkward and unskillful individuals, it is not surprising that it should be approached with apprehension. But when performed by a skillful hand and with a suitable instrument, the operation is always safe, and in a large majority of the cases may be effected with ease.

Dr. Fitch relates a case which will serve to illustrate the above remarks. The subject, a resident of Botetourt County, Va., in having the second right superior molar extracted by a blacksmith, had a large portion of the jaw and five other teeth removed at the same time. "The roots of his tooth," says Dr. Fitch, "were greatly bifurcated and dovetailed into the jaw, and would not pass perpendicularly out, though a slight lateral motion would have moved them instantly. The jaw proved too weak to support the monstrous pull

upon it, and gave way between the second and first molars, and with it came both the anterior and posterior plates of the antrum. The broken portion extended to the spongy bones of the nose, and terminated at the lower end of the socket of the left front incisor, containing six sound teeth, namely, the first molar, the bicuspids, cuspid, and incisors of the right side—six in all. The soft parts were cut away with a knife. A severe hemorrhage ensued, but the patient soon recovered, though with excessive deformity of his face and mouth."

Dr. Cross, of North Carolina, related to the author, in 1838, a case very similar to the one just quoted. The operator in this, as in the other instance, was a blacksmith. In attempting to extract one of the superior molar teeth, he brought away a piece of the jaw containing five other teeth, together with the floor of the antrum and its posterior and anterior walls.

We have adverted to these cases to show the impropriety and danger of intrusting the operation to individuals possessing neither knowledge of its principles nor skill in its performance. Injuries occasioned by the operations of such persons have frequently come under the immediate observation of the author, with whom it has always been a matter of surprise that an operation to which such universal repugnance is felt should ever be confided to them.

The removal of a wrong tooth, or of two or three instead of one, are such common occurrences that it were well if the precautions given by the illustrious Ambrose Paré were more generally observed. So fearful was he of injuring the adjacent teeth, that he always isolated the tooth to be extracted with a file before he attempted its removal. He regarded it as of the greatest importance that a person who extracted teeth should be expert in the use of his "tooth mullets; for unless he knows readily and cunningly how to use them, he can scarcely so carry himself but that he will not force out three teeth at once." Although great improvements have been made since his time in the construction of extraction instruments, yet even now the accidents to which he alludes are of almost daily occurrence.

It is surprising that an operation so frequently called for should receive so little attention from medical practitioners, by whom, though not strictly belonging to their province, it must frequently be performed. This neglect can only be accounted for by the too general prevalence of the idea that little or no surgical skill is necessary to its performance. But every physician residing in the country, or where the services of a skillful dentist cannot always be commanded, should provide himself with the proper instruments,

and make himself acquainted with the manner of performing this operation.

INDICATIONS FOR THE EXTRACTION OF TEETH.

With regard to the indications that determine the propriety of extraction, the author does not deem it necessary to say much in this place, as they are fully pointed out in other parts of the work. It may be well, however, to briefly mention, in this connection, a few of the circumstances which call for the operation.

Beginning with the teeth of first dentition, it will be sufficient to state that when a tooth of replacement is about to emerge from the gums, or has actually made its appearance, either before or behind the corresponding milk tooth, the latter should at once be removed; and when the aperture formed by the loss of this is so narrow as to prevent the former from acquiring its proper position, it may sometimes be necessary to extract an adjoining temporary tooth. For more explicit directions upon this subject, the reader is referred to the chapter on second dentition. Alveolar abscess, necrosis of the walls of the alveolus, and pain in a temporary tooth which cannot be cured by any of the usual remedies, may be regarded as indications which call for the operation.

The principal conditions which should determine the extraction of a permanent tooth may be enumerated in the following order:—

First, when a molar, from the loss of its antagonizing tooth, or from other causes, has become partially displaced, or is a source of constant irritation to the surrounding parts.

Second, a constant discharge of fetid matter from the pulp cavity through a carious opening in the crown. There may, however, be circumstances which would justify a practitioner in permitting or even advising the retention of such a tooth, as, for example, when the discharge of fetid matter is not very considerable; also, where the tooth is situated in the anterior part of the mouth, and cannot be securely replaced with an artificial substitute. The secretion of fetid matter may in some cases, by judicious treatment, be arrested, the tooth preserved for many years by plugging, and so the morbid influence it would otherwise exert upon the surrounding parts may be counteracted. A front tooth should not be sacrificed unless called for by some very urgent necessity; neither should an upper incisor nor cuspid be permitted to remain in the mouth if it exerts a manifestly morbid action upon the surrounding parts, for in this case the consequences resulting from its retention in the mouth may be worse than the loss of the tooth.

Third, a tooth which is the cause of an incurable alveolar abscess,

should not be permitted to remain; but if it be an incisor or cuspid, and the discharge of matter through the gum is small, occurring only at long intervals, and especially if the organ cannot be securely replaced with an artificial substitute, it may be permitted to remain. An incurable abscess in the socket of a bicuspid or molar should always be considered as a sufficient indication for the removal of the tooth.

Fourth, irregularity in the arrangement of the teeth, arising from disproportion between the size of the teeth and the size of the alveolar arch, usually requires for its correction the extraction of some one or more teeth. But with regard to the teeth most proper to be removed the reader is referred to the chapter on irregularity, where he will find full directions for the management of such cases.

FIG. 486.

Fifth, all dead teeth and roots of teeth which act as irritants, and teeth which have become so much loosened, from the destruction of their sockets, as to be a constant source of disease to the adjacent parts, or teeth otherwise diseased that are a cause of neuralgia of the face, disease of the maxillary sinus, dyspepsia, or any other local or constitutional disturbance, such teeth should, as a general rule, be extracted.

There are other indications which call for the extraction of teeth, but the foregoing are among the most common; they will be found sufficient in most instances to determine the propriety or impropriety of the operation. Cases are, however, continually presenting

themselves to which no fixed rule would be found applicable, and where an experienced judgment alone can determine the practice proper to be pursued.

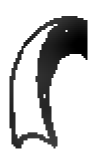
In conclusion, it is scarcely necessary to say, that whenever a tooth can be restored to health it should always be done; but tampering with such as cannot be rendered healthy and useful, and which, by remaining in the mouth, exert a deleterious influence, not only upon the adjacent parts, but also upon the general health, cannot be too strongly deprecated.

Fig. 485 represents the permanent teeth of the left side, a study of which will enable the student to form a correct idea concerning crowns and roots of the different classes of teeth.

INSTRUMENTS EMPLOYED IN THE OPERATION.

Different operators employ different instruments. For about fifty years the key of Garengeot was almost the only instrument used in the performance of the operation; but this has in a great

FIG. 486.



measure been superseded by forceps, which, when properly constructed, are far preferable; yet as the key is still used by some, and by them is considered, in certain cases, a valuable instrument, a brief description of it is here given.

Key Instrument.—"The common tooth-key," says Dr. Arnot, "may be regarded in the light of a wheel and axle, the hand of the operator acting on two spokes of the wheel to move it, while a tooth is fixed to the axle by the claw and is drawn out as the axle turns. The gum and alveolar process of the jaw form the support on which the axle rolls."

Different dentists have their keys differently constructed, but the principle upon which they all act is precisely the same. Some prefer the bent shaft (Fig. 486), others the straight. Some give a de-

cided preference to the round fulcrum, others to the flat; and though the success of the operator depends greatly upon the perfection of the instrument, yet he may remove a tooth more expertly by means of a key with which he is familiar than by one to which he is unaccustomed, though its construction be even better. Fig. 486 represents a key with bent shaft and two hooks, one for molars and the other for bicuspids.

The author has tried almost every variety of key instrument that has been used in this country, and thinks the straight shank, with a small round fulcrum slightly flattened on each side, decidedly preferable to any other. The objection raised by some to the use of such a key, that it is liable to interfere with the front teeth, is without good foundation. It can be used with as much safety as a key of any construction, and in most cases can be as easily applied. The round is certainly preferable to the flat fulcrum, because it is less liable to injure the gums and the alveolus. In size it should be a little larger than a half-ounce bullet.

Every key instrument should be supplied with several hooks, differing in size, to suit the teeth upon which they are to be applied. The hook described by Dr. Maynard* is preferable to any which the author has seen. It very nearly resembles the eagle's claw, except that its curvature is rather greater. The edge of the hook is about the sixteenth of an inch in width and divided into two points by a shallow notch. A hook of this description is less liable to slip, and can be more readily applied to a tooth than those ordinarily used.

With regard to the merits of the key instrument, or of any other instrument having the same principle of action, as compared with the forceps presently to be described, the author does not entertain a very high opinion. The following remarks, quoted from the late work of M. Desirabode, accord with the views which he has held and promulgated for many years: "One of the most common causes of fracture of the alveoli is a badly performed operation in the mouth; although not a very flattering acknowledgment for our art, it is necessary to say it. If it be necessary to specify causes, we would not hesitate to name, in the first place, the use of the key of Garengeot; for we shall prove, in treating of the extraction of teeth, that this *dangerous* implement, which is only fit to mask the unskillfulness of the operator, is one of the most defective of surgical instruments; and no practitioner of good sense, being convinced of

* See Am. Jour. Dent. Sci., No. 3, vol. iii.

its mode of action, would attempt to use it even to extract a nail from a board, if he did not desire to break the surrounding material." Perhaps this condemnation is too sweeping. The principle of action of the key is, in fact, not unlike that of a nail drawer or tack puller, and is well adapted to a certain class of cases, namely, where one wall, either the inner or outer, is decayed below the alveolus, while the opposite one is still standing. The fulcrum, with a folded napkin or other soft substance interposed, is placed against the gum on the side of the tooth most decayed and the hook adjusted to the neck of the tooth on the opposite side.

Manner of Using the Key Instrument.—The directions required for the use of the key are few and simple, but as cases frequently occur to which no general rules can be applied, much will depend on the practical judgment and surgical tact of the operator. The first step to be taken in the operation is to separate the gum from the neck of the tooth down to the alveolus; this should be done, not on two sides only, but round the entire tooth. For this purpose suitable lancets should be provided. A straight, narrow-bladed knife, pointed at the end and with one cutting edge, will be found most convenient for performing the operation on the approximal sides; it may be most effectively used by passing the point of the knife between the neck of the tooth and gum down to the alveolus, with its back downward, then cutting in the direction of the crown. In this way the connection of the gum to the sides of the neck of the tooth may be thoroughly severed. The same kind of knife or a common gum-lancet may be used for separating the gum from the remaining sides of the tooth. If the gum is not well separated there will be danger of lacerating it in the removal of the tooth.

After the tooth has been thus prepared, the key, with the proper hook attached, should be firmly fixed upon it; the fulcrum, on the inside, resting upon the edge of the alveolus, the extremity of the claw on the opposite side, pressed down upon the neck. The handle of the instrument is then grasped with the right hand and the tooth raised from its socket by a firm, steady rotation of the wrist. The claw should be pressed down with the forefinger or thumb of the left hand of the operator until, by the rotation of the instrument, it becomes securely fixed upon the tooth. This precaution is necessary to prevent it from slipping, an accident that frequently happens, and one that is always more or less embarrassing to the dentist.

If the tooth is situated on the left side of the mouth, the position of the operator should be at the right side of the patient; but if it be on the right side he should stand before him. For the removal

of a tooth on the left side of the lower jaw, or the right side in the upper, the palm of the hand should be beneath the handle of the instrument; in the extraction of one on the right side of the lower jaw, or on the left side in the upper, it should be above. The manner of grasping the instrument is of more importance than many suppose. If improperly held the operator loses, to a great extent, his control over it.

The directions here given are, in some respects, different from those laid down by other writers; but we are convinced, from much experience, that they will be found more conducive to the convenience of the operator and the success of the operation than those usually given for the use of this instrument.

There is a diversity of opinion as to whether a tooth should be removed inwardly or outwardly. Some direct the fulcrum of the instrument to be placed to the outside of the mouth, others to the inside, or on the neck of the tooth itself, while others again regard it as of little importance on which side it is placed. Experience has taught us that it should, in the majority of cases, be placed on the inside, especially of the lower teeth, as they almost always incline toward the interior of the mouth. Moreover, the edge of the alveolus is usually a little higher on the exterior edge of the jaw than on the interior; so that the first motion of the instrument, with its fulcrum on the outside, brings the side of the tooth against its socket; thus nearly double the amount of power is required to remove it, while, at the same time, the pain and the chances of injury to the alveolar processes are very much increased.

It is, however, frequently necessary to place the bolster of the key on the outside of the tooth; when, for instance, it is decayed in such a way as not to afford a sufficiently firm support for the claw of the instrument. But whenever it is possible to remove a tooth inwardly it should be done. The alveolar walls of the upper teeth are generally thinner than those of the lower, and do not afford so strong a support to the fulcrum of the instrument.

Forceps.—Forceps were not very generally or extensively employed, except for the extraction of the front teeth, until about the year 1830; but the improvements made in their construction since that period are so great that their use has now, among dentists, superseded that of the key.

The forceps formerly used were so awkwardly shaped and so badly adapted to the teeth that the extraction of a large molar with an instrument of this description was regarded as exceedingly difficult, and even dangerous; even its practicability was doubted by many of

the most experienced practitioners, and hence the key was almost the only instrument resorted to for the purpose.

When we consider the strong prejudice that formerly existed against the use of forceps it is not at all wonderful that their employment should have been resorted to with caution. Nor is it surprising that a gentleman of Mr. Bell's intelligence and practical experience should, so late as the period of the publication of the first edition of this work, 1830, tell us that the key is the only instrument to be relied upon for the removal of teeth that are much decayed, and that those who have heaped the most opprobrium upon it are glad to have a concealed recourse to its aid.

This may have been true at the time Mr. Bell wrote, but not now. On the contrary, cases have occurred of the extraction of teeth with forceps upon which the key had been previously unsuccessfully employed. It is generally supposed that a greater amount of force is necessary to remove a tooth with forceps than with the key, but this is a mistake. It does not ordinarily require as much. The leverage gained by the action of the key is more than counterbalanced by the greater amount of resistance encountered in the lateral direction of the force exerted in the removal of the tooth by that instrument. But with forceps, the direction of the power being in the line of the axis of the tooth, an amount sufficient to break up the connection with the sockets and to overcome the resistance of the walls of the alveolus is all that is required; and any tooth can be extracted with the forceps that can be removed with the key; and that, too, in the majority of cases, with greater ease to the operator and less pain and danger to the patient.

In order that forceps may be used with ease, it is necessary they should be properly constructed. Every operator should possess a number of pairs (nine at least), each with a differently shaped beak adapted to the necks of the teeth to which they are respectively designed to be applied.

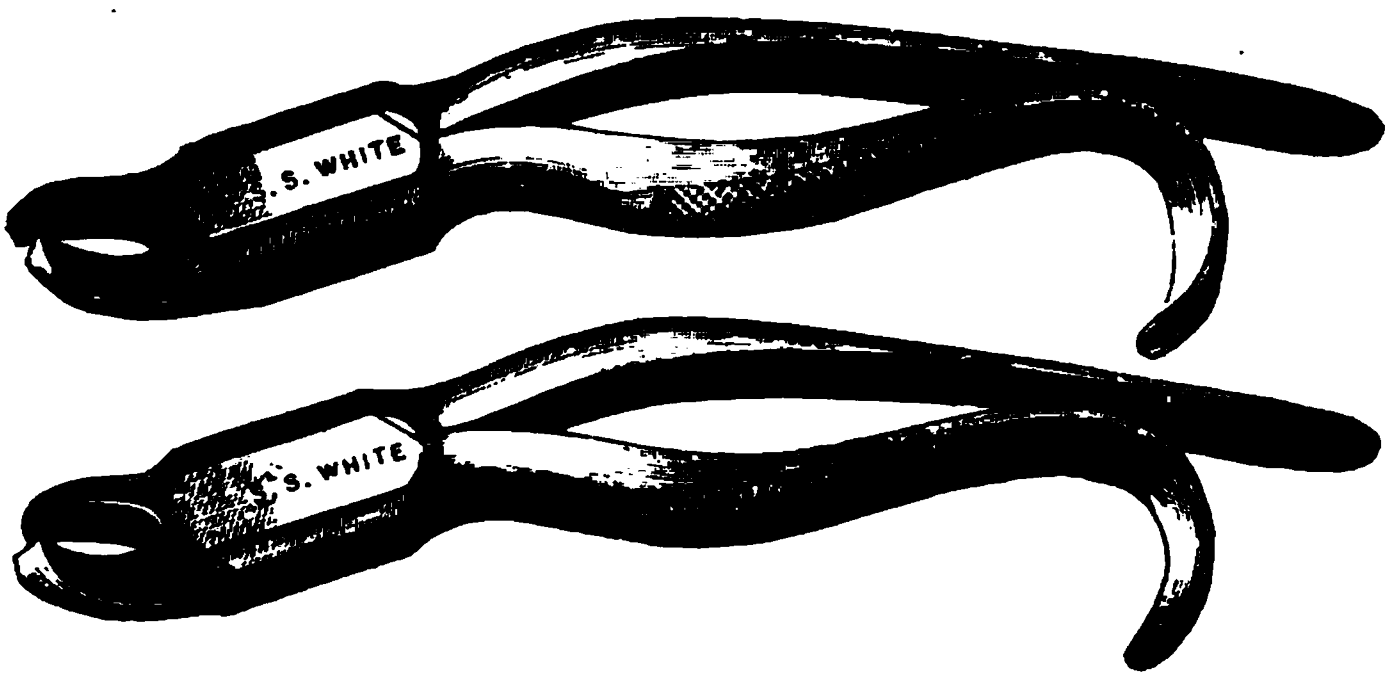
For the upper molars two (Fig. 487) are required, one for each side, curved just below the joint, so that the beak shall form an angle of twenty or twenty-five degrees with the handles, just enough to clear the lower teeth. The inner blade is grooved to fit the neck of the palatine root; the outer blade has two grooves, with a point in the centre to fit the depressions just below the bifurcation of the two buccal roots. Another valuable improvement consists in having one of the handles bent so as to form a hook. This passes round the operator's little finger, to prevent the hand from slipping.

Fig. 448 represents another form of superior molar forceps, right

and left, with a greater curvature in the handles than the Harris pattern, which many consider an improvement.

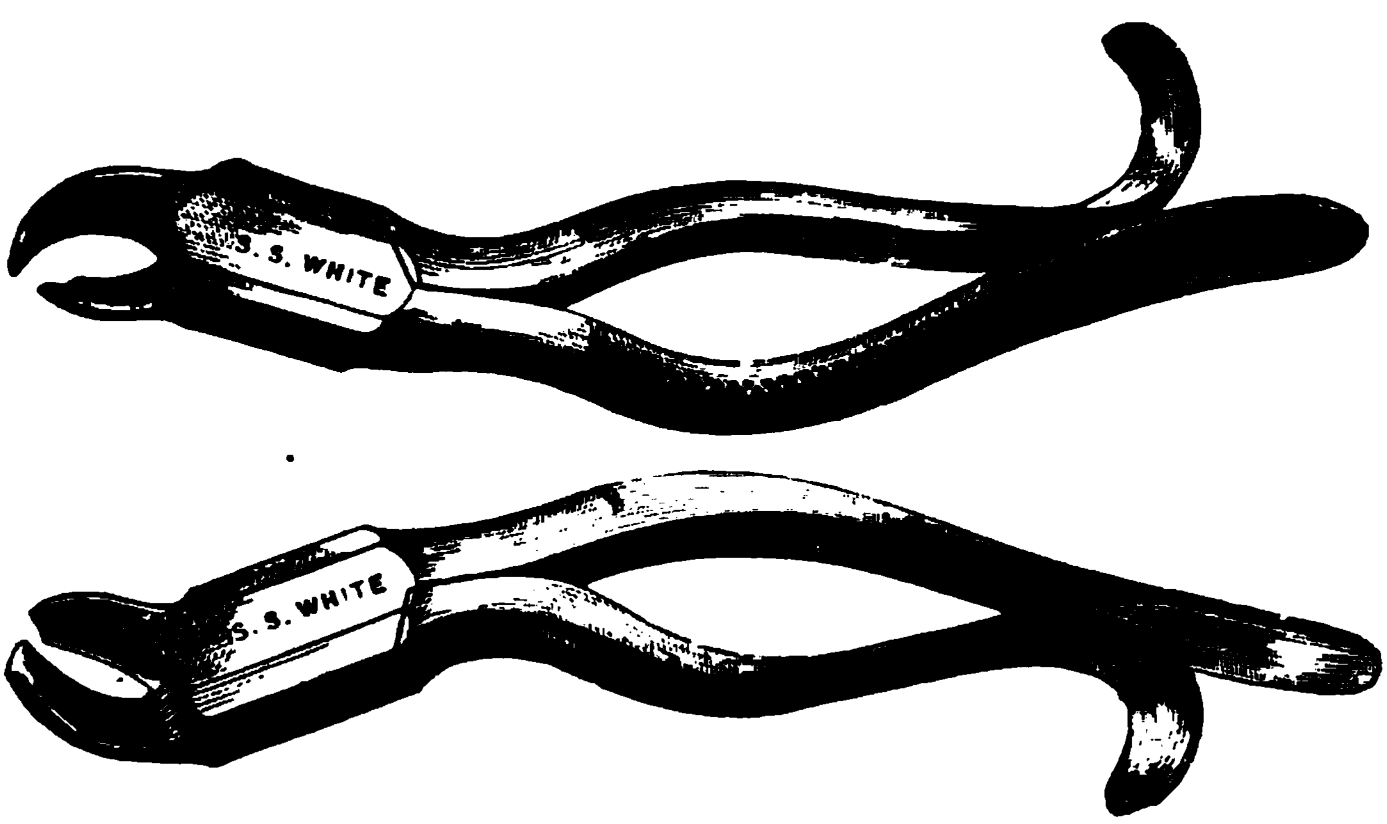
The handles should be wide and large enough to prevent them from springing under the grasp of the hand, to which they should

FIG. 487.



be accurately fitted. Every dentist, therefore, in having forceps manufactured, should give special directions with regard to their shape and size. The beak should be bent no more than is absolutely necessary to prevent the handles from coming in contact with

FIG. 488.

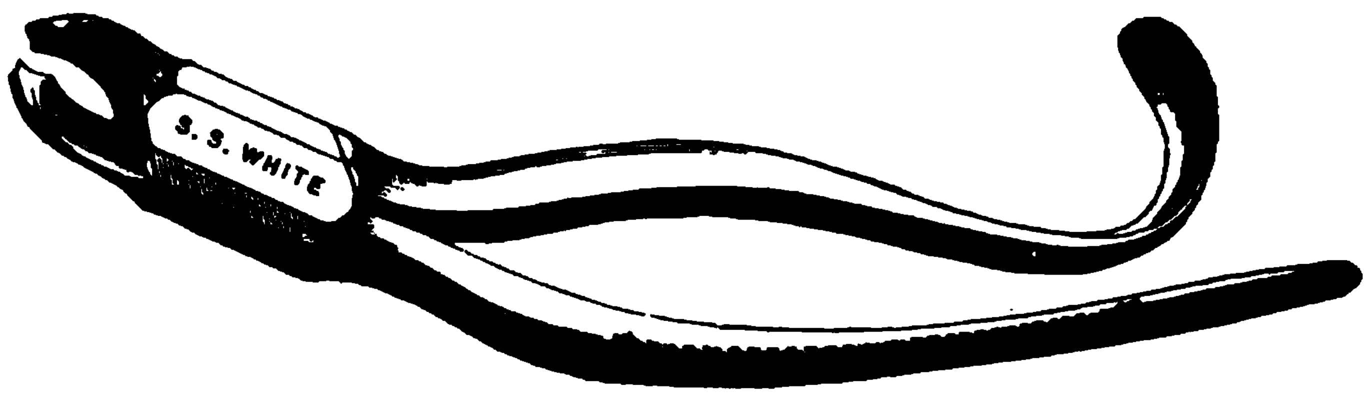


the teeth of the lower jaw; for in proportion to the degree of curvature will the muscular power of the operator be disadvantageously exerted.

Each blade of the beak of the lower molar forceps has two grooves, with a point in the centre so situated that in grasping the tooth it

comes between the two roots just at the bifurcation. An improvement made by the author in 1833 consists in having the handles of the instrument so bent that it may be as readily applied to one side of the mouth as the other, while the operator occupies a position to the right and a little behind the patient. By this improvement the necessity for two pairs is superseded; it, moreover, enables him to

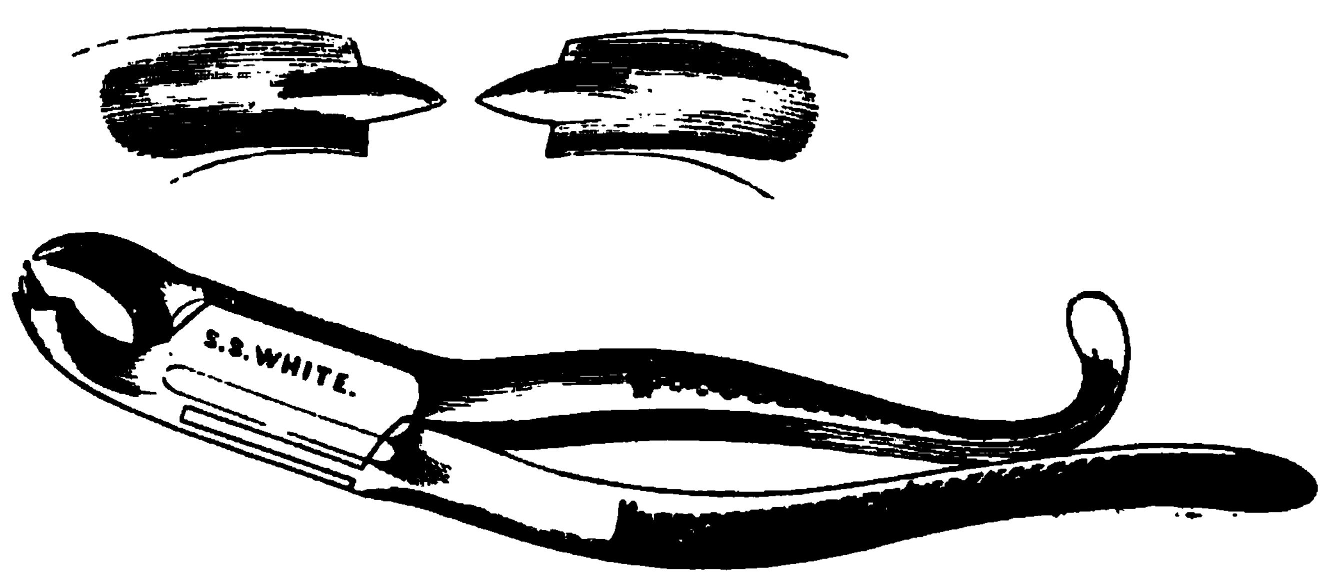
FIG. 489.



control the head of the patient with his left arm and the lower jaw with his left hand, rendering the aid of an assistant wholly unnecessary.

The shape of the instrument as improved by the author is shown in Fig. 489. It is now used by many hundreds of operators, who prefer it to any other instrument they have ever employed. When applied to a tooth the handles turn toward the operator at an angle

FIG. 490.



of about twenty-five or thirty degrees. Without this curvature in the handles the arm of the operator would often be thrown so far from his body as to prevent the proper control over the instrument. It is also important that the handles should be wide and accurately fitted to the hand. The inferior dentes sapientiæ can also, in the majority of cases, be removed with this form of forceps.

Fig. 490 represents Wolverton's inferior molar forceps for either side, with longer points in the centre of each blade of the beak,

which answer a good purpose where the roots slightly diverge and admit the points within the bifurcation.

Fig. 491 represents inferior molar forceps for the right and left sides of the mouth, which some prefer to the single forceps, on account of the position of the hand grasping the instrument.

FIG. 491.

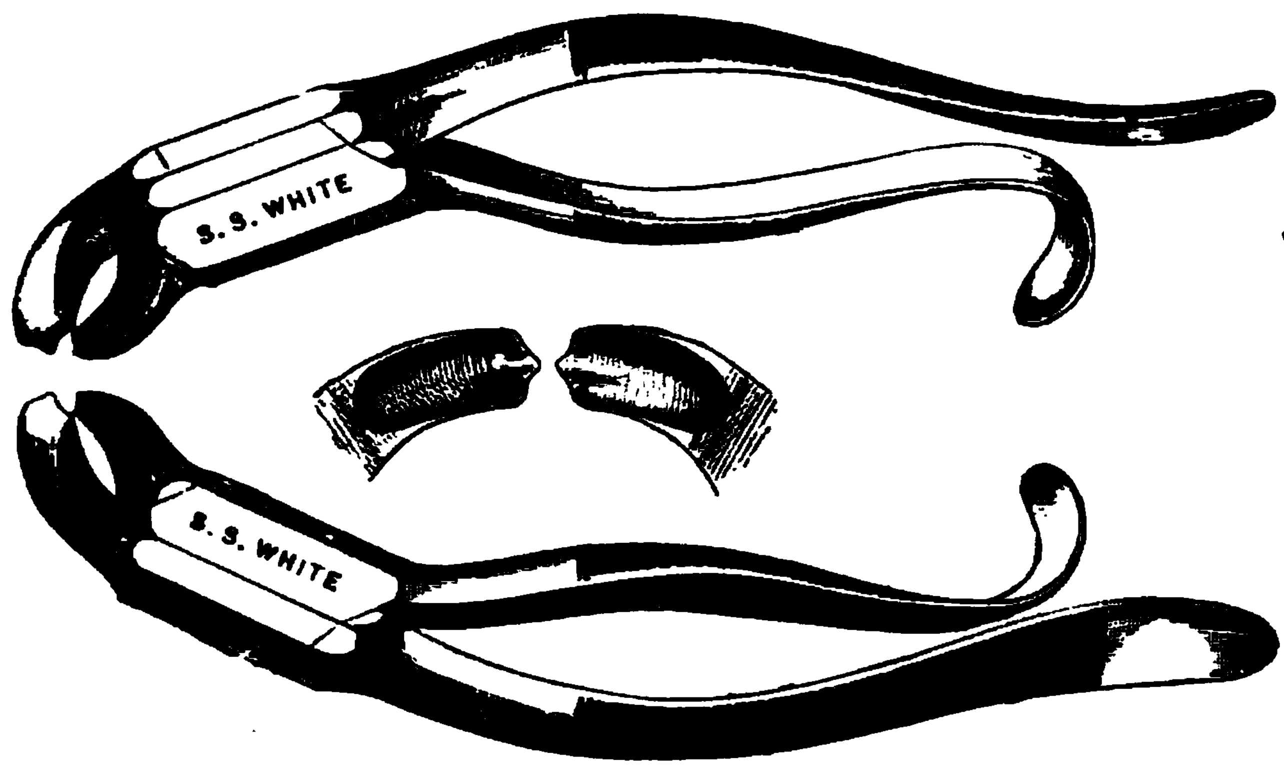


Fig. 492 represents a lower molar forceps with plain beaks, for use on either side, intended more especially, however, for the inferior third molars.

For the extraction of the upper incisors and cuspids one pair only may be used, although an instrument with the inner concave beak somewhat narrower than the outer conforms more nearly to the shape of the necks of the superior cuspids, and is preferred by many

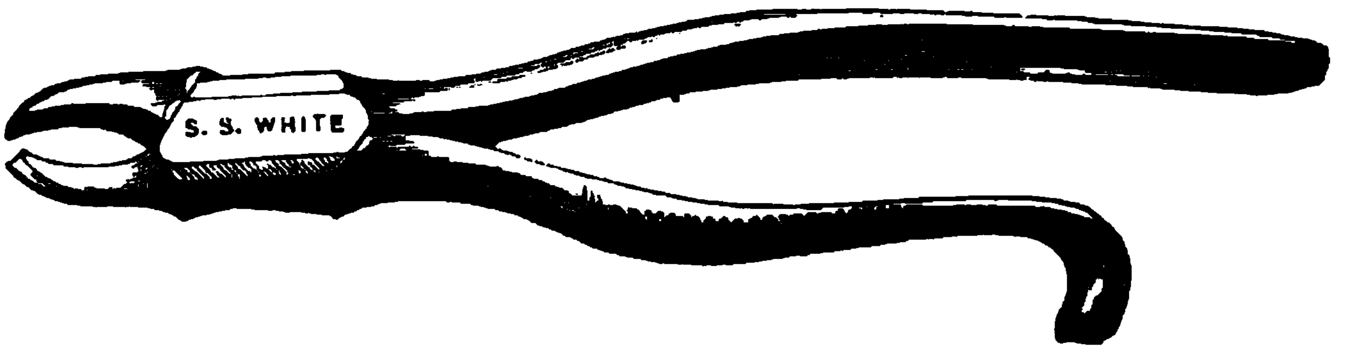
FIG. 492.

for the removal of these teeth. (Fig. 493.) These should be straight, with grooved or crescent-shaped jaws accurately fitted to the necks of the teeth. The beaks should also be thin, so that they may be easily introduced under the gum, up to the edge of the alveolus. And, like the superior and inferior molar forceps, the handles should be large enough to prevent them from springing in the hand of the operator, with a hook formed at the end of one of them.

Owing to the difference in size between the superior central and

lateral incisors, forceps with beaks much narrower than those of the common form of superior incisor forceps are frequently required for

FIG. 493.



the extraction of the latter teeth. Fig. 494 represents an upper lateral incisor forceps with narrow beaks.

FIG. 494.

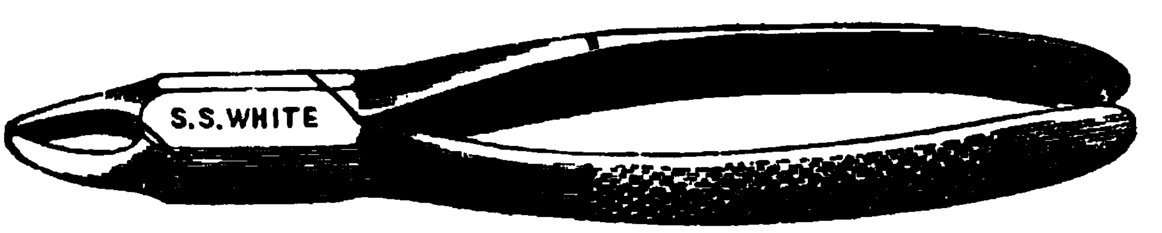
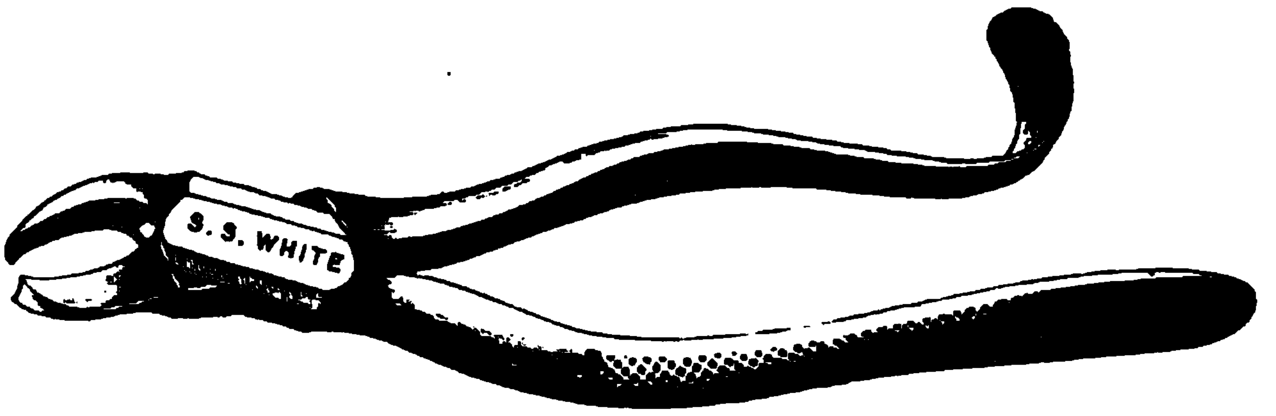


Fig. 495 represents another form of a superior cuspid and bicuspid forceps, in which the beaks curve more than those of the incisor forceps.

FIG. 495.



For the extraction of the lower incisors a pair of very narrow beaked forceps are necessary, to prevent interfering with the teeth

FIG. 496.

adjoining the one to be removed. The beak below the joint of the instrument should be bent downward at an angle of about twenty-

five degrees with the handles. (Fig. 496.) This is also a very valuable instrument for the extraction of the roots of teeth.

An instrument similarly shaped, but with the beak much longer, makes one of the most universally applicable instruments that can be devised. (Fig. 497.) The beak should be made strong, but very narrow.

FIG. 497.

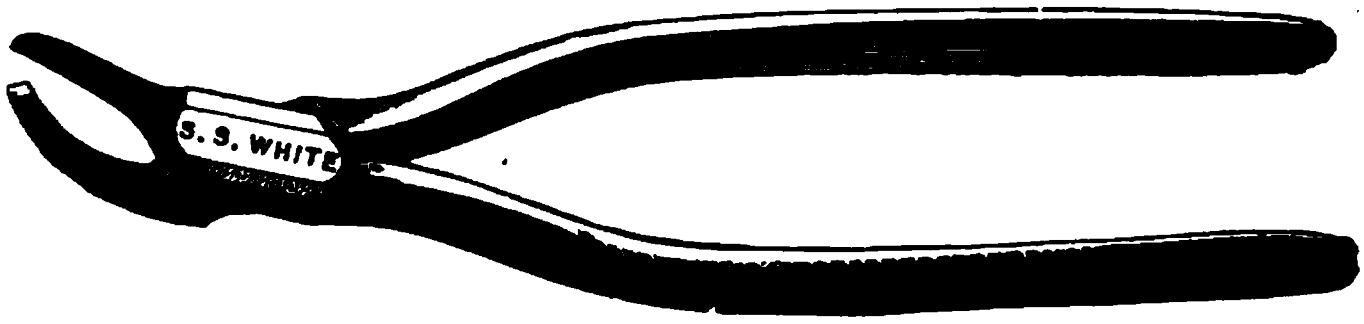
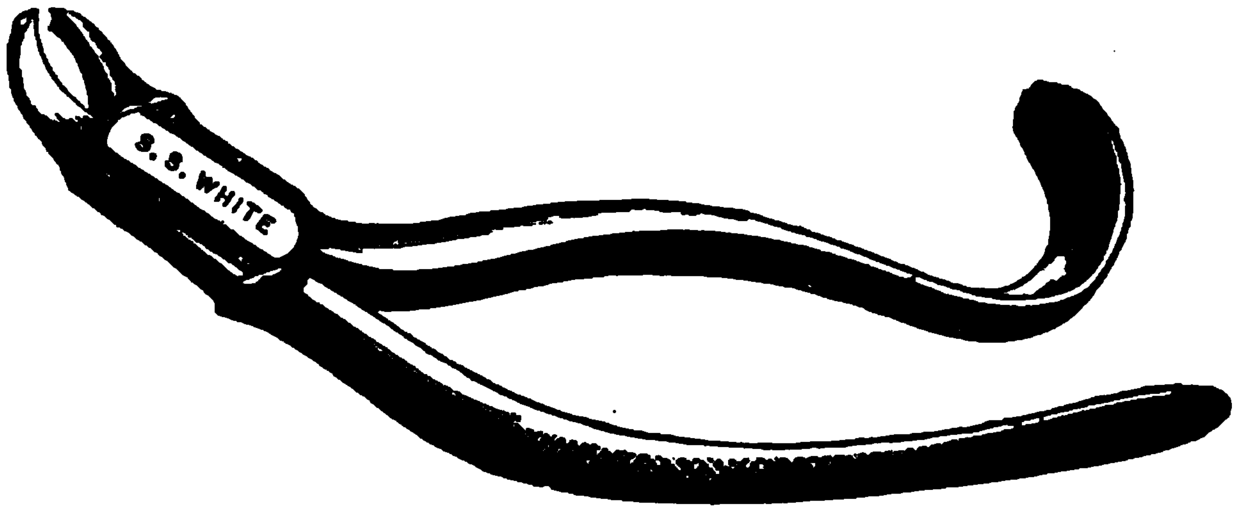


Fig. 498 represents an inferior incisor hawk-bill forceps, which is a very convenient instrument for the removal of these teeth. It is also used for the removal of the lower cuspids.

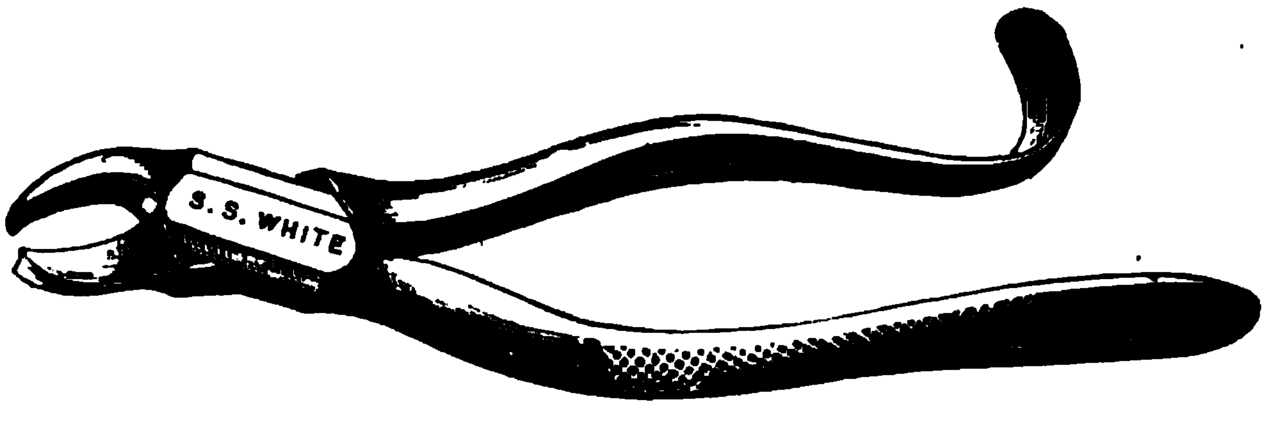
Forceps for the extraction of bicuspids should have their jaws so bent as to be easily adapted to these teeth; they should be narrow

FIG. 498.



and have a deeper groove on the inside than those for the upper incisors and cuspids; like them, they should be thin, yet strong

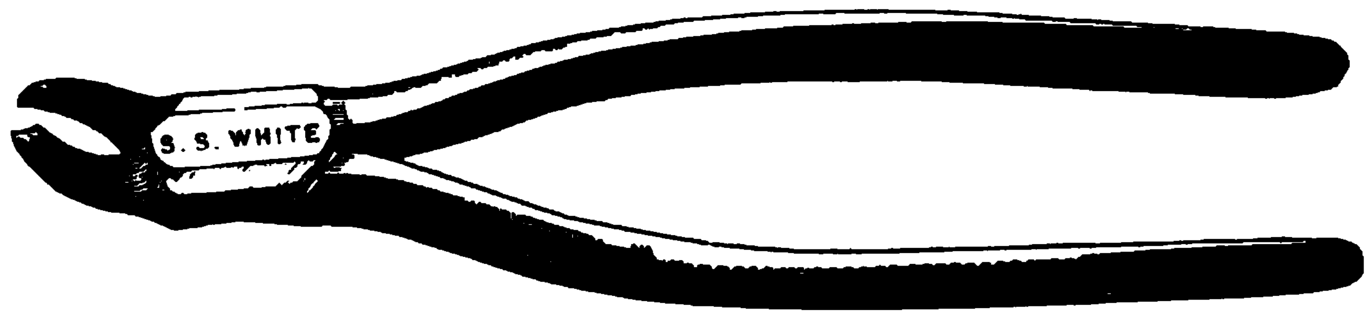
FIG. 499.



enough to sustain the pressure which it may be necessary to apply. One pair will answer for the right and left bicuspids of the upper jaw. (Fig. 499.)

For the removal of the cuspids and bicuspids of the lower jaw the hawk's-bill forceps (Fig. 498), with crescent-shaped beaks, is often employed; but the instruments represented in Figs. 500 and 501 are, we think, better suited to the extraction of these teeth, and

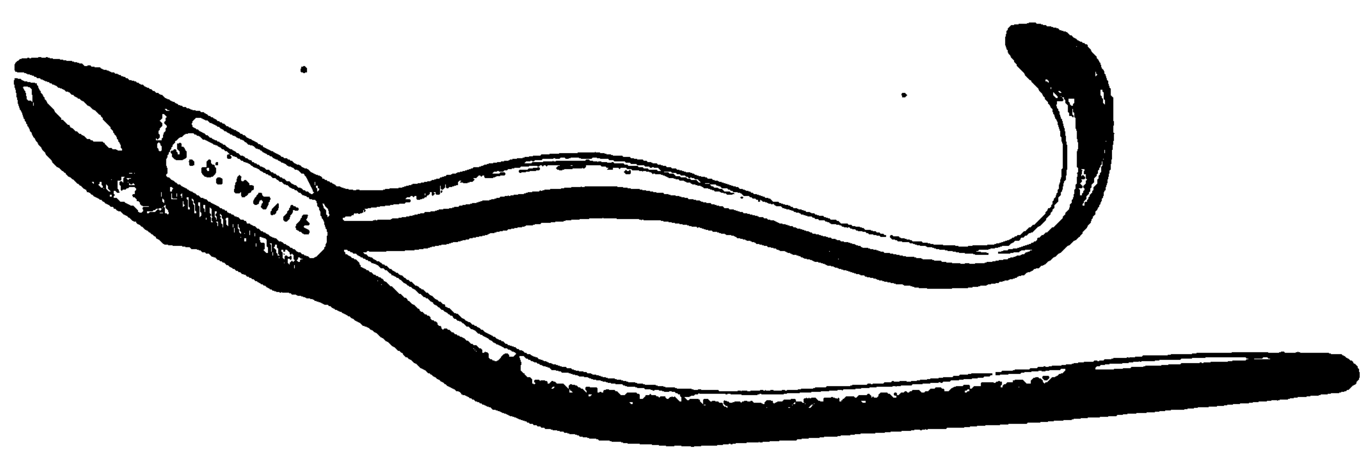
Fig. 500.



can be more conveniently applied. No separate instrument, therefore, is required for the removal of the inferior cuspids.

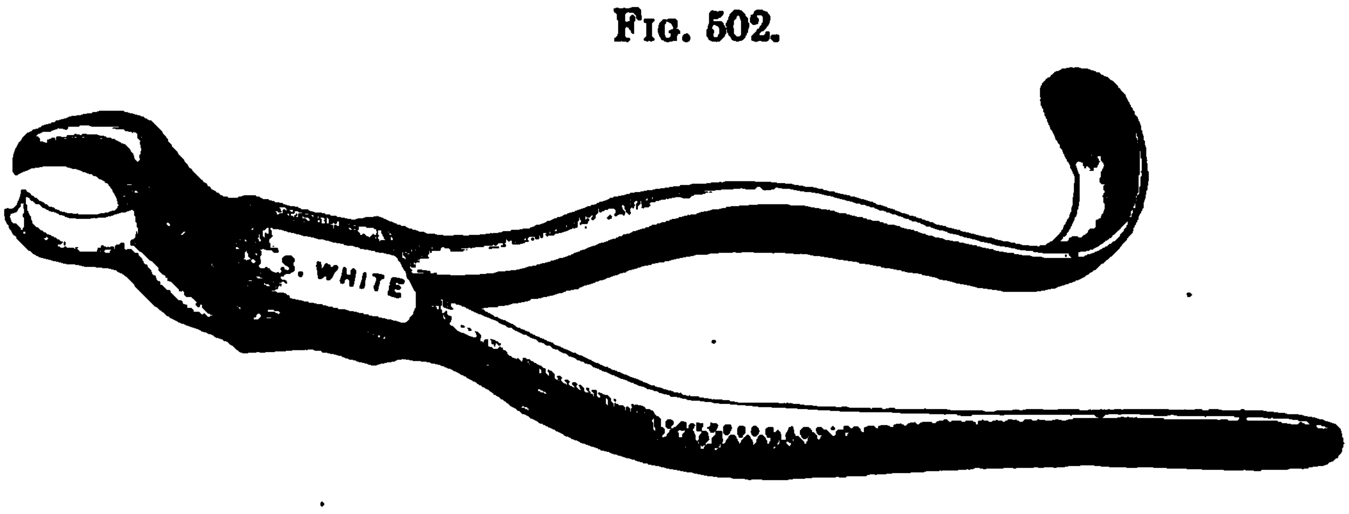
The dentes sapientiæ can, in many cases, be extracted with the universal bicuspid forceps, as shown in Fig. 500, which is half curved,

Fig. 501.



with two concave beaks. But there is another kind of forceps which may be more conveniently employed for the removal of the upper wisdom teeth. The beak of these is bent above the joint, forming nearly two right angles, as shown in Fig. 502. These forceps

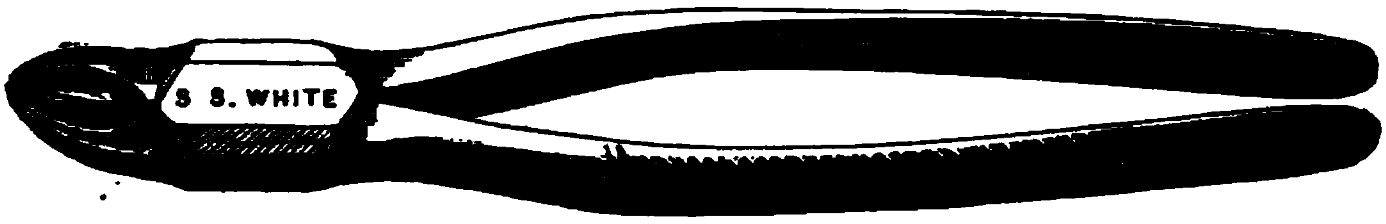
Fig. 502.



were, we believe, invented by Dr. Edward P. Church about the year 1830, and in those cases where the superior dentes sapientiæ are considerably shorter than the second molars, they can be successfully and advantageously employed; and, indeed, in many

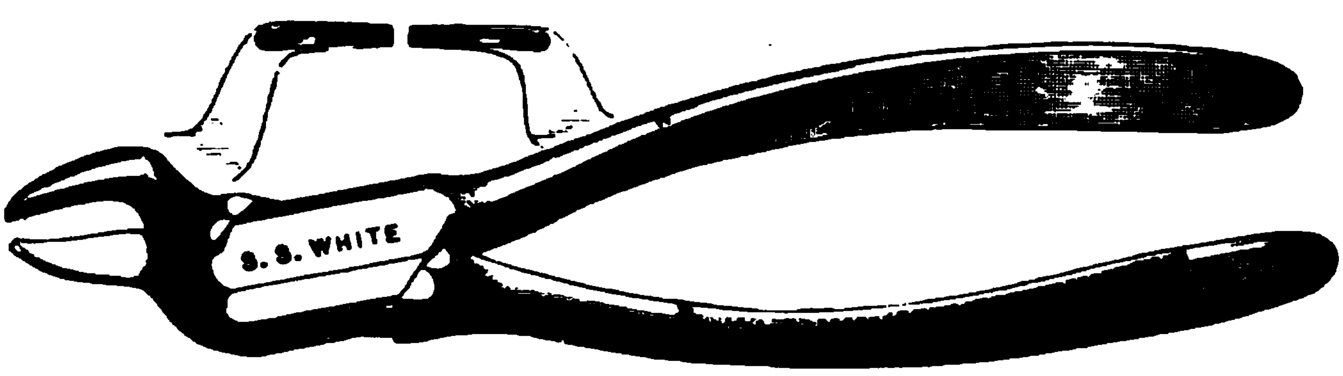
cases, they cannot be reached with any of the above-described extracting instruments. The handles of these, as of all other forceps,

FIG. 503.



should be no longer than is absolutely necessary for the accommodation of the hand of the operator.

FIG. 504.

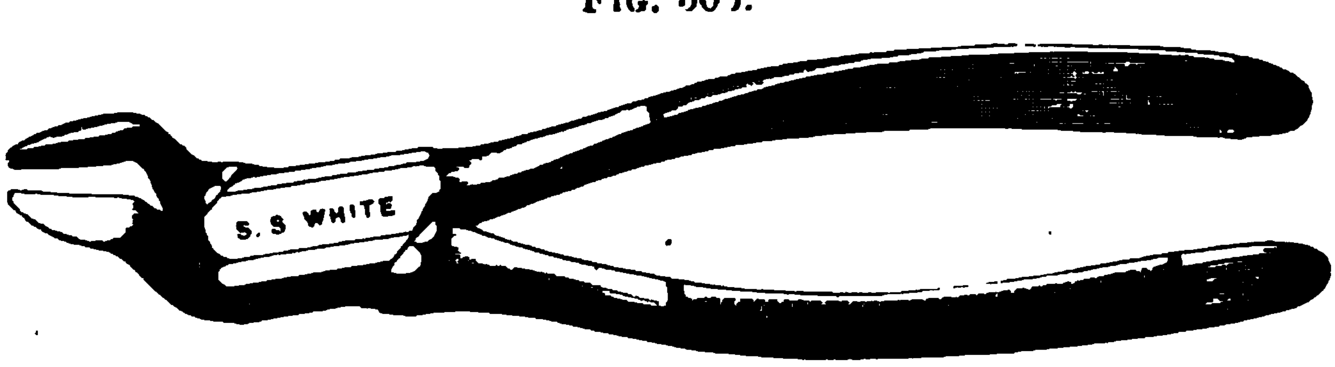


For the removal of the inferior dentes sapientiæ, the forceps represented in Fig. 489, Harris's pattern, or the ones represented in

FIG. 505.

Figs. 491 and 492 may be employed. Fig. 503 represents Physick's dentes sapientiæ for either side, which is used as an elevating forceps.

FIG. 503.

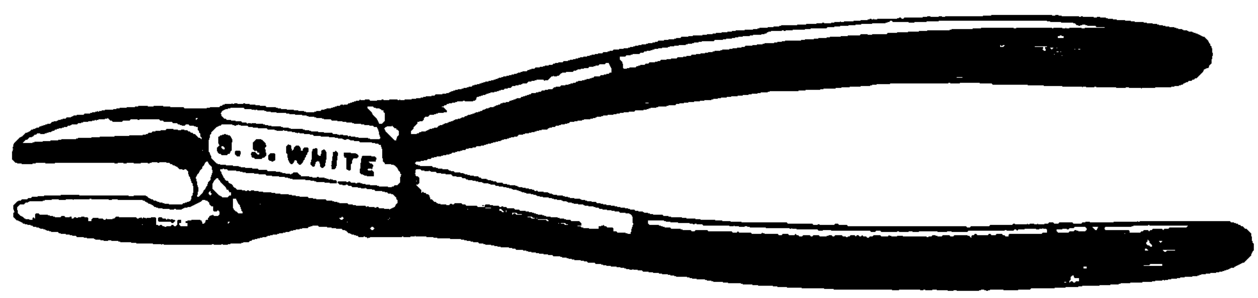


For the removal of the roots of the teeth the inferior incisor forceps represented in Figs. 496 and 497 are very useful; also the forms represented in Figs. 504 and 505.

Figs. 506, 507, 508, 509, and 510 represent Parmley's patterns of alveolar forceps for cutting through the alveolar process to the roots of the teeth.

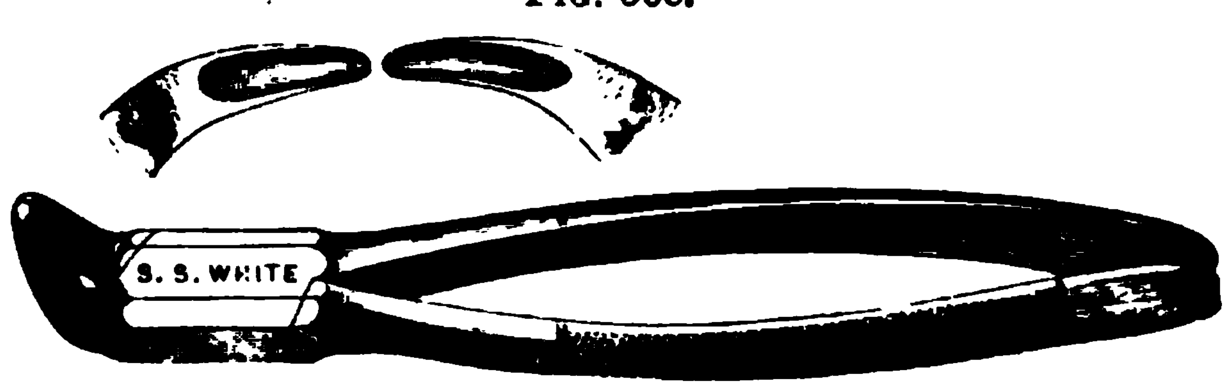
The form of forceps represented by Fig. 510 is very useful for the extraction of inferior cuspids and bicuspids, both right and left; also for the extraction of roots of inferior teeth.

Fig. 507.



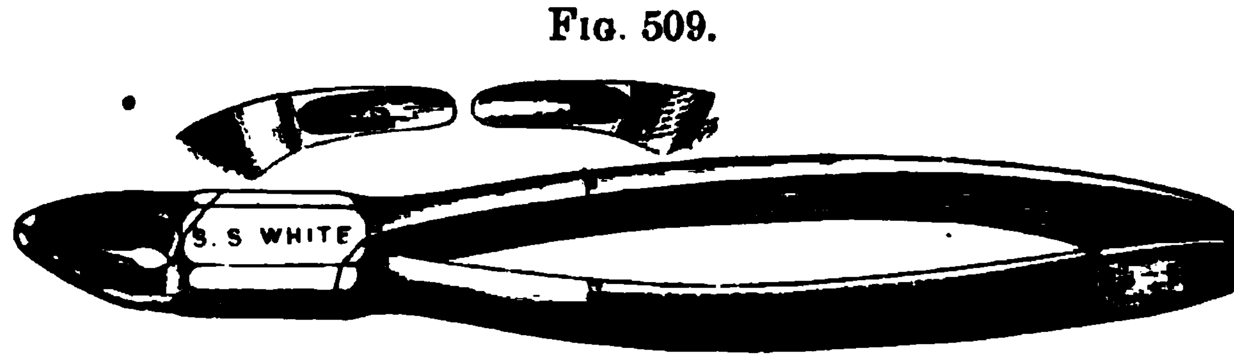
Figs. 511 and 512 represent Stellwagen's superior and inferior forceps for separating the diverging roots of molar teeth, and which may also be used as elevating forceps.

Fig. 508.



There is scarcely any instrument used in dentistry that has called forth more ingenuity in devising various shapes than forceps.

Fig. 509.



Almost every practitioner has some peculiar pattern of his own, which will accomplish what no other can. Doubtless many of these instruments are very excellent; but it often happens that an inventor learns by dint of practice to do with some pet forceps of his own contrivance what might as easily have been done with a simpler

one already in use. We would not, however, be understood as saying that patterns in present use admit of no improvement. What

FIG. 510.

we do assert is, that skill in the use of a few instruments is preferable to crowding one's case with an unnecessary number.

FIG. 511. (*Superior.*)

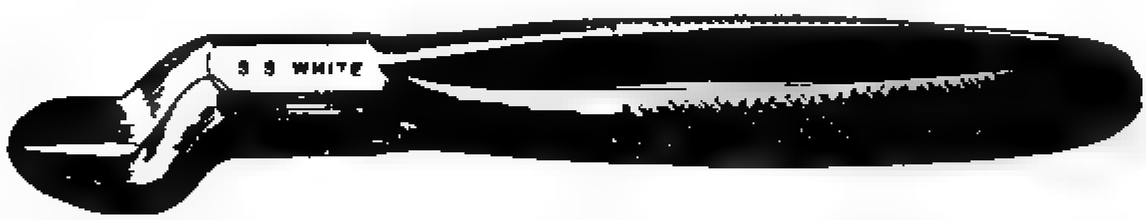
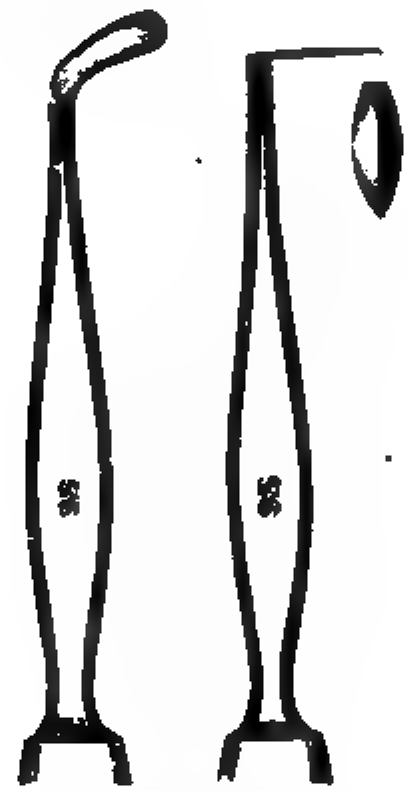


FIG. 512. (*Inferior.*)

MANNER OF USING THE FORCEPS.

In describing the manner of using these instruments we shall commence with the extraction of the incisors of the upper jaw. These are generally more easily removed than any of the other teeth.

FIG. 513.



The use of the gum lancet should generally precede the application of either the forceps or the key. Many dentists object to the operation as unnecessarily inflicting double pain. Some have their forceps made with thin, sharp blades, so as to sever the gum on two sides in the act of pressing up the instrument. This practice may be admissible, perhaps necessary, in certain exceptional cases, as with children or nervous persons, whom the act of lancing might deter from permitting the operation to be completed. But we are fully satisfied that, as a rule, it is very objectionable, either in the use of the key or of the forceps. Owing to the great improvement in the form of the edges of the beaks of the forceps now manufactured, the use of the gum lancet is scarcely necessary, except in the case of teeth that stand alone, where lancing of the gum may prevent the laceration or tearing of the soft tissues, and also in the case of the wisdom teeth and roots of teeth imbedded in the gum.

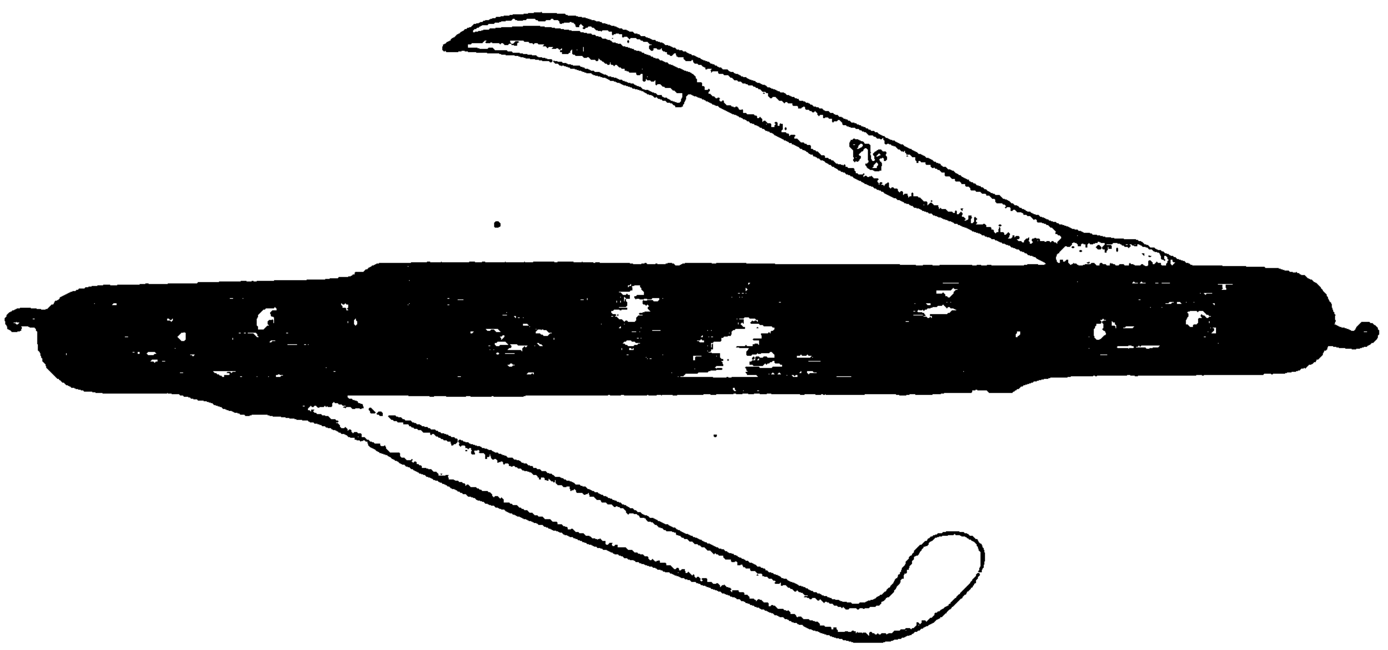
Figs. 513 and 514 represent several forms of gum lancets.

Fig. 514 represents a convenient two-blade gum lancet with stop.

After separating the gum, when necessary, from the neck of the tooth, it should be grasped with a pair of straight

forceps (Fig. 493 or Fig. 495, or, in case the tooth is a lateral incisor, with a narrow crown, Fig. 494), and pressed several times in quick succession outward and inward, giving it at the same time a slight rotary motion, which should be continued until it begins to give way; then, by a slight downward pull, it is easily removed. If the tooth is much decayed, it should be grasped as high up under the

FIG. 514.



gum as possible, and no more pressure applied to the handles of the instrument than may be necessary to prevent it from slipping. Teeth are often unnecessarily broken by not attending to this precaution.

The same directions will, in most cases, be found applicable for the removal of a lower incisor. But the arrangement of these teeth is sometimes such as to render their extraction rather more difficult. The forceps best calculated for their removal are represented in Figs. 496 and 498.

For the extraction of a cuspid more force is usually required than for the removal of an incisor, because of the greater size and length of its root. The straight forceps (see Fig. 493 or Fig. 495) should be employed for the removal of the superior, and the curved-beaked forceps (Figs. 496, 501, and 510) for the inferior cuspids. In the extraction of these teeth less rotary motion should be given to the hand than in the removal of the incisors; in every other respect the operation is performed in the same manner. The inferior cuspids usually have longer roots, and are more difficult to remove than the superior.

Very little rotary motion can be given to a bicuspid, especially an upper one, in its extraction. After it has been pressed outward and inward several times, or until it begins to give way, it should be removed by pulling in the direct line of its axis. For the extraction of the upper, the forceps represented in Fig. 493 and Fig. 495, and

for the lower, those represented in Fig. 501 and Fig. 510 are the proper instruments to be employed, unless the crown has become so much weakened by decay that it will not bear the requisite amount of pressure. In this case the gum on each side should be separated from the alveolus about an eighth or three-sixteenths of an inch, and slitted so as to permit the application of the narrow-beaked forceps, Fig. 496. With these the alveolar wall on each side may be easily cut through, and a sufficiently firm hold obtained upon the root of the tooth for its removal. The forceps represented in Fig. 520 and Fig. 521 will be found better adapted for the removal of the molars, when in a similar condition, than any other instrument.

The upper molars, having three roots, generally require a greater amount of force for their removal than any of the other teeth. They should be grasped as high up as possible, with one of the forceps represented in Fig. 487 or 488, and then pressed outward and inward until the tooth is well loosened, when it may be pulled from the socket. If the forceps used for the extraction of the upper molars are of the right description and properly applied, they will be found the safest and most efficient instruments that can be employed for their removal.

The superior dentes sapientiæ are usually less firmly articulated to the jaw than are the first and second molars; they are therefore more easily removed. When their crowns are sufficiently long to admit of being grasped with the bicuspid forceps (Fig. 500), they may be removed with this instrument; but when this cannot be applied without interfering with the anterior teeth, the forceps represented in Fig. 501 may be substituted.

The inferior molars, although they have but two roots, are often very firmly articulated, and require considerable force for their removal; and it sometimes happens that, when the approximal side of one has been destroyed by caries, the adjoining tooth has impinged upon it in such a manner as to constitute a formidable obstacle to its extraction. Two teeth are often removed in attempting to extract one thus situated, unless the precaution is taken of filing off the side of the encroaching tooth. This should never be omitted in the extraction of a lower molar or bicuspid locked in the manner just described. It sometimes, though less frequently, happens that the upper teeth impinge upon each other in the same manner; in this case, also, the adjoining tooth should be filed sufficiently to liberate the one that is to be extracted before attempting its removal. In applying forceps to an inferior molar, the points on the beak of the instrument should be forced down between the

roots; after having obtained a firm hold, the tooth should be forced outward and inward several times in quick succession, until its connection with the jaw is partially broken up, and then raised from the socket. If the tooth has decayed down to the neck, the points of the beak may include the upper edge of the alveolus, through which they will readily pass on applying pressure to the handles, and in this manner a secure hold will be obtained upon the tooth. The same should also be done in the extraction of a superior molar in this condition.

The dentes sapientiæ in the lower jaw, when situated far back under the coronoid processes, are oftentimes exceedingly difficult to extract; but with forceps like those represented in Figs. 489, 492, or 510, they may always be grasped by an expert operator, except in those cases where their crowns have been destroyed by caries, when the cowhorn forceps represented in Fig. 522 will generally prove useful. It occasionally happens that the roots of these teeth are bent in such a manner as to constitute a considerable obstacle to their removal. But when this is the case, the roots are almost always turned posteriorly toward the coronoid processes; so that after starting the tooth, if the operator is unable to lift it perpendicularly from the socket, he will have reason to suspect its retention to be owing to an obstacle of this nature. To overcome this, as he raises his hand he should push the crown of the tooth backward, making it describe the segment of a circle; for should he persist in his efforts to remove it directly upward, the root will be broken and left in the jaw. Fig. 503 represents an elevating forceps useful in removing the dentes sapientiæ when they are but partially erupted or badly decayed. The points of the beaks of this forceps are inserted between the second molar and partially erupted wisdom tooth, the crown of the second molar being the fulcrum.

It sometimes happens that the roots of the first and second molars of both jaws and those of the superior dentes sapientiæ are bent, or else diverge or converge so much as to render their extraction exceedingly difficult. The convergency of these roots is often so great that, in their removal, the intervening wall of the alveolus is brought away; but neither from this, nor from the removal of a portion of the exterior wall, will any unpleasant results follow. Similar malformations are occasionally met with in the roots of the bicuspids, the cuspids, and even the incisors.

Other obstacles sometimes present themselves in the extraction of teeth, which the judgment and tact of the operator alone will enable him to overcome. The nature and peculiarity of each case will suggest the method of procedure most proper to be pursued.

The dentist should never hesitate to embrace a portion of the alveolus between the jaws of the forceps when necessary to enable him to obtain a firm hold upon the tooth. The removal of the upper edge of the socket is never productive of injury, as it is always subsequently removed, more or less rapidly, by the process of absorption. When the crown of a tooth has become so much weakened by disease that it will not bear the pressure of the instrument, it may be removed in this manner without inflicting upon the patient half the pain that would be caused by the attempt to spare the thin, perishable alveolar walls.

MANNER OF EXTRACTING ROOTS OF TEETH.

The extraction of roots of teeth is sometimes attended with considerable difficulty; but generally they are more easily removed than the whole teeth, especially the roots of the molars, for, after the destruction of their crowns, an effort is usually made by the economy to expel them from the jaws. This is done by the gradual absorption of the alveolus, together with the filling up of the socket by a deposition of ossific matter at the bottom, whereby the articulation of the root becomes weakened and its removal rendered proportionately easier. The alveolar cavities are often wholly obliterated in the course of two or three years after the destruction of the crowns of the teeth, and the roots retained in the mouth simply by their connection with the gums, so that for their removal little more is necessary than to sever this bond of union with a lancet or sharp-pointed knife.

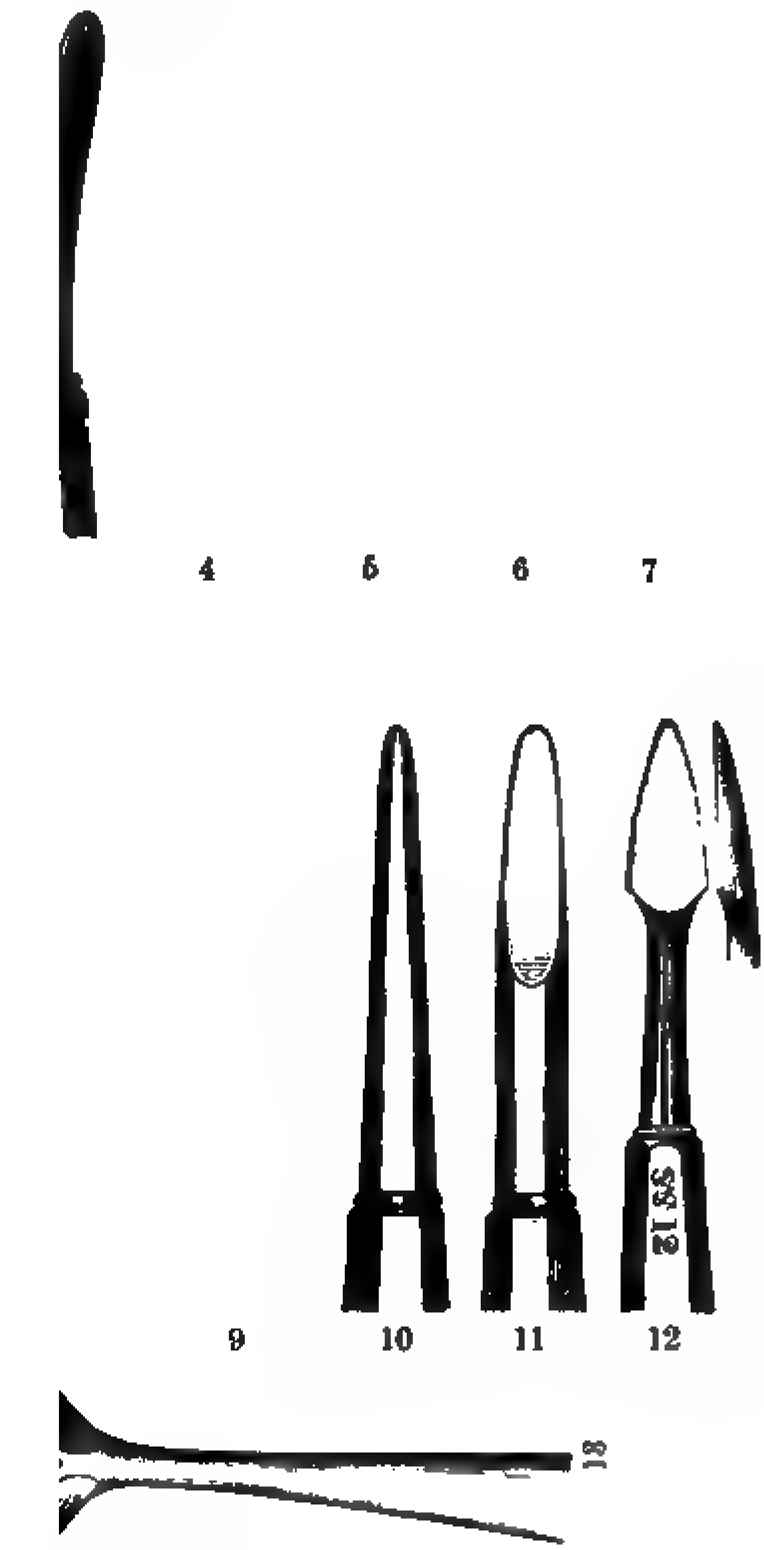
The instruments usually employed in the extraction of roots of teeth are the hook, punch, elevator, and screw, all of which are represented in Fig. 515, and also the root forceps shown in subsequent figures. Although every dentist has the former made to suit his own peculiar notions, the manner of using them and the principles upon which they act are the same. It will, therefore, be sufficient to say that they should be of a convenient size, made of good steel, and so tempered as neither to bend nor break.

The hook, No. 7, Fig. 515, is chiefly used for the extraction of the roots of molar and bicuspid teeth on the left side of the mouth; the punches, Nos. 3, 4, 5, 6, 10, 11, 12, Fig. 515, for the removal of those on the right side; the elevators, Nos. 2, 8, 9, 13, Fig. 515, for the extraction of roots on either side, as occasion may require; and the screw, No. 1, Fig. 515, for the removal of those of the upper front teeth.

Considerable tact is necessary for the skillful use of these instruments, and this can only be obtained by practice. Great care is

requisite, in using the punch and elevator, to prevent them from slipping and injuring the mouth of the patient. Whenever, therefore, either of these are used, the forefinger of the left hand of the operator should be wrapped with a napkin and placed on the side

Fig. 516.



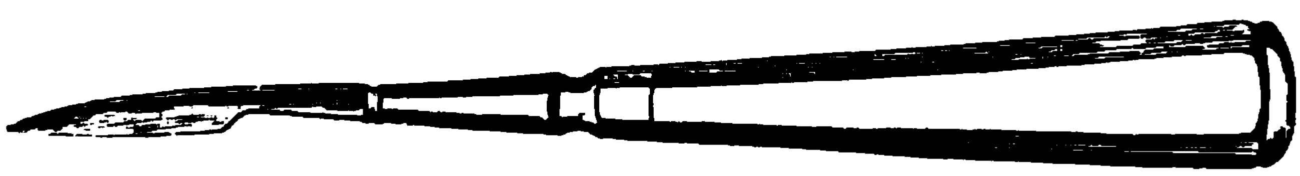
of the root opposite to that against which the instrument is applied, so as to catch the point in case it should slip.

But for the removal of the roots of bicuspids and molars, and often for those of the cuspids and incisors, the narrow-beaked for-

ceps recommended for the extraction of the lower incisors (see Fig. 496) may be used more effectively than any other instrument. When the root is decayed down to the alveolus the gum should be separated from it, and so much of it as may be necessary to obtain a secure hold upon the root included between the beaks of the forceps, for these, being very narrow, readily pass through the alveolus and a firm hold is at once obtained upon the root; then, after moving it a few times outward and inward, it may easily be removed from its socket.

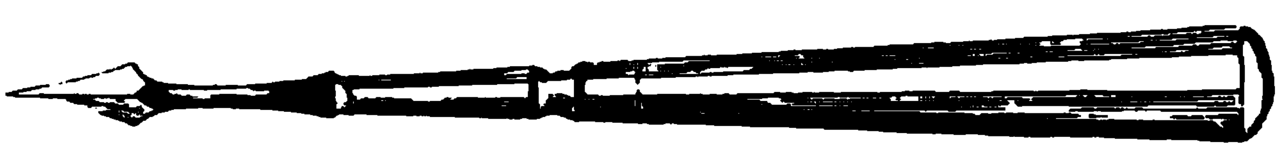
There are some cases, however, in which the punch, hook, and elevator may be advantageously used. We have also occasionally

FIG. 516.



met with cases where we have succeeded in removing roots of teeth with great ease by means of an elevator shaped like the blade of a knife, first forcing it into the socket by the side of the root and then turning it so as to make the back press against the former and the edge against the latter. When this instrument, represented in Fig. 516, is used, the blade should not be more than an inch in length, and it should be straight, short at the point, and have a very thick back, that it may not break in the operation. In using the common elevator it is necessary that there should be an adjoining tooth or

FIG. 517.



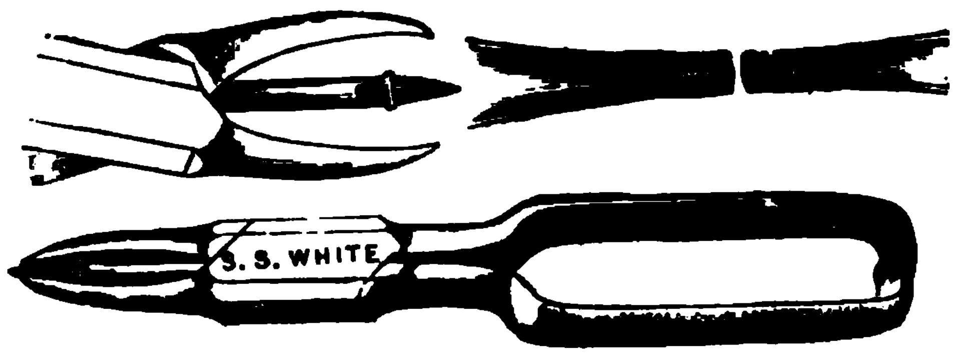
root to act as a fulcrum. When this can be employed, a root, or even a whole tooth, may sometimes be removed with it; but, as a general rule, forceps should be preferred to any of these instruments.

For the extraction of the roots of the upper front teeth, after they have become so much funneled out by decay as to render their walls incapable of sustaining the pressure of forceps, the conical screw may be employed. With this a sufficiently firm hold for the removal of the root can be obtained by screwing it into the cavity. But before it is introduced the soft decomposed dentine should be removed from the interior of the root with a triangular-pointed instrument like the one represented in Fig. 517.

Dr. S. P. Hullihen has invented a most valuable and useful

instrument for the removal of the roots of the superior incisors and cuspids when in the condition just described. It combines the advantages both of the screw and forceps, as may be seen by the accompanying cut. It is thus described by the author: "Lengthwise, within and between the blades of the beak, is a steel tube, one end of which is open, the other solid and flat, and jointed in a mortise in the male part of the joint of the forceps. When the forceps are opened, this joint permits the tube to fall backward and forward from one blade of the beak to the other, without any lateral motion. Within this tube is a spiral spring, which forces a shaft up two-thirds of the tube; the other part is a well-tapered or conical screw. . . . The shaft and tube are so fitted together and to the beak of the forceps

FIG. 518.



that one-half of the rounded part of the shaft projects beyond the end of the tube, so that the shaft may play up and down upon the spring about half an inch, and the screw or shaft be embraced between the blades of the beak of the instrument."

Dr. Hullihen's instrument is represented in Fig. 518.

"The forceps," says Dr. Hullihen, "are used by first embracing the shaft between the blades.* Then, screwing it as gently and deeply into the root as possible, the blades are opened and pushed up on the root, which is then seized and extracted. The screw thus combined with the forceps prevents the root from being crushed. It acts as a powerful lever when a lateral motion is given; it is likewise of advantage when a rotary motion is made; it prevents the forceps from slipping or from losing their action should one side of the root give way in the act of extracting it, and is used with equal advantage where one side of the root is entirely gone."

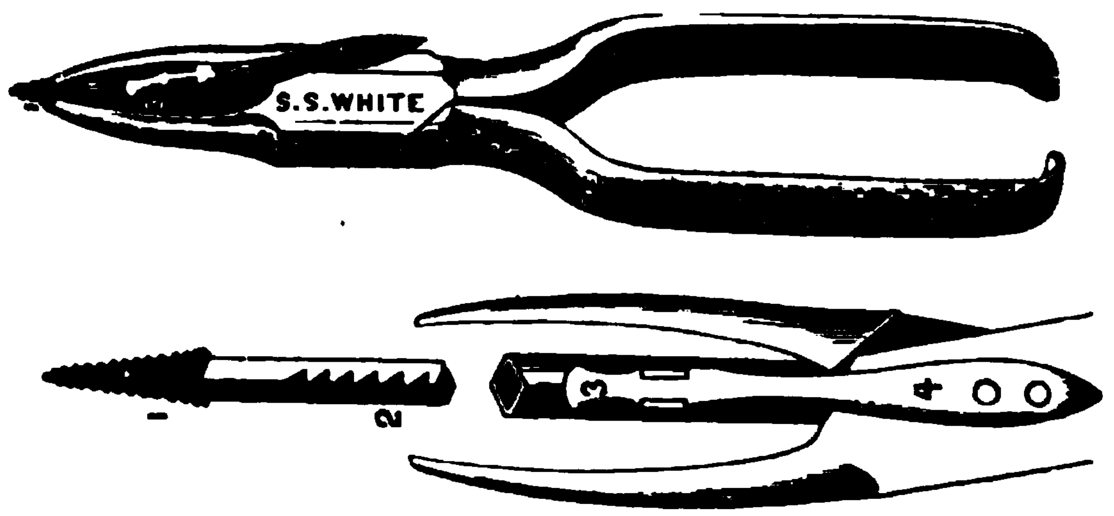
Fig. 519 represents Dubs's screw forceps: 1. Conical screw, with square ratchet shaft. 2. Beaks of forceps, grooved inside. 3. Socket with square hole to receive shaft. 4 Spring trigger, by which the screw can be detached at pleasure at any given point.

For the extraction of the roots of the upper molars before they

*The author has a pair constructed so that the blades of the beak of the forceps grasp the upper extremity of the screw instead of the shaft.

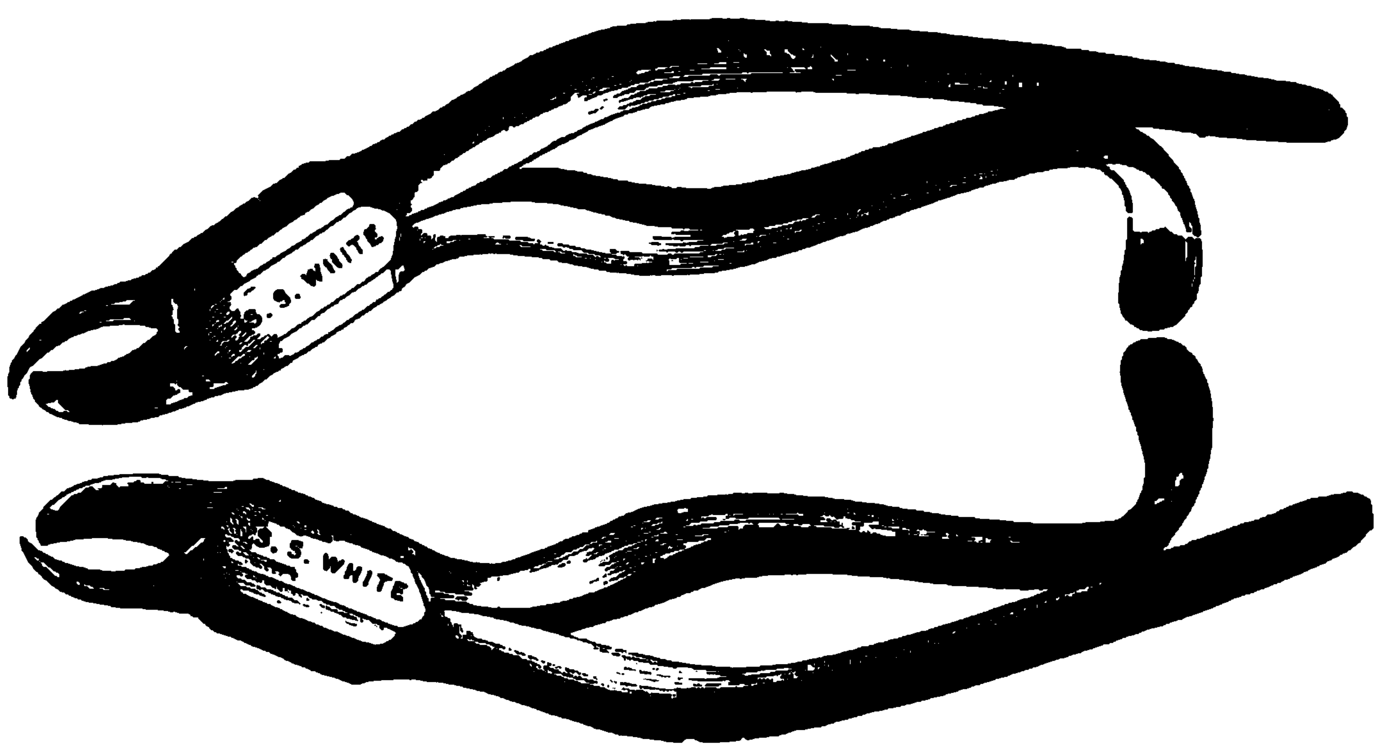
have become separated from each other by decay, the forceps (Fig. 520) invented by Dr. Maynard will be found highly valuable. The

FIG. 519.



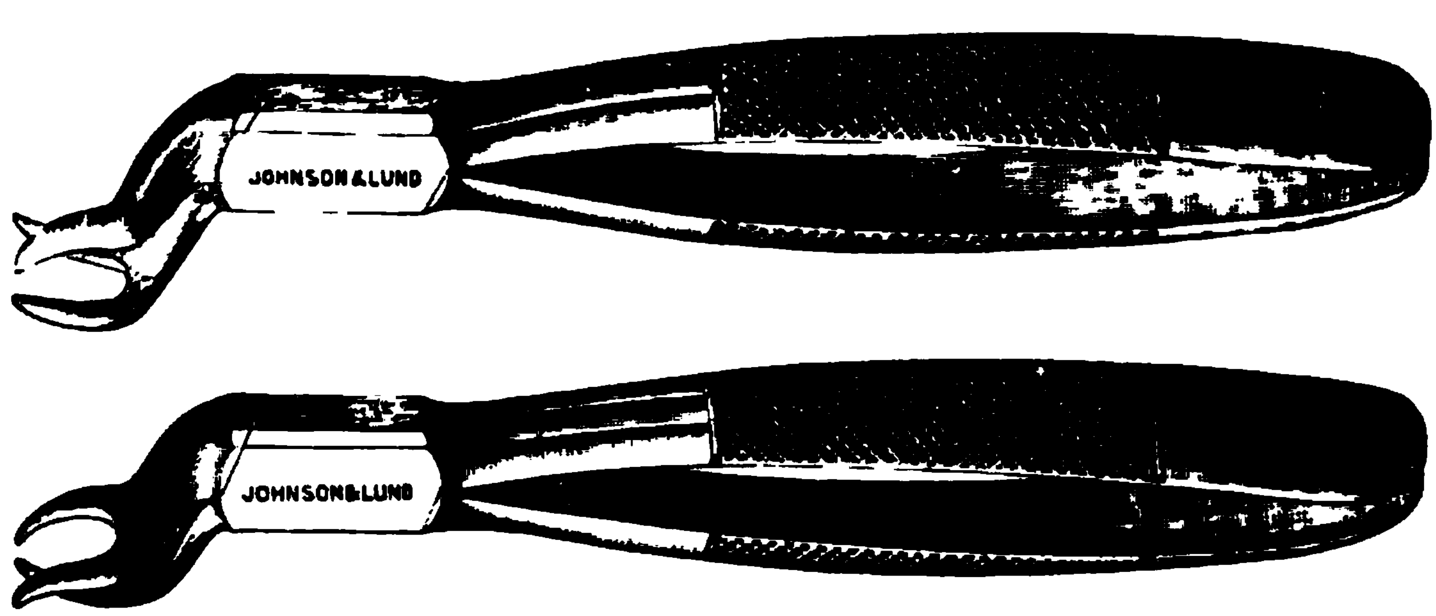
outer beak of each instrument is brought to a sharp point for perforating the alveolus between the buccal roots and for securing be-

FIG. 520.



tween them a firm hold, while the inner beak is intended to rest upon the edge of the alveolus and embrace the palatine root. By

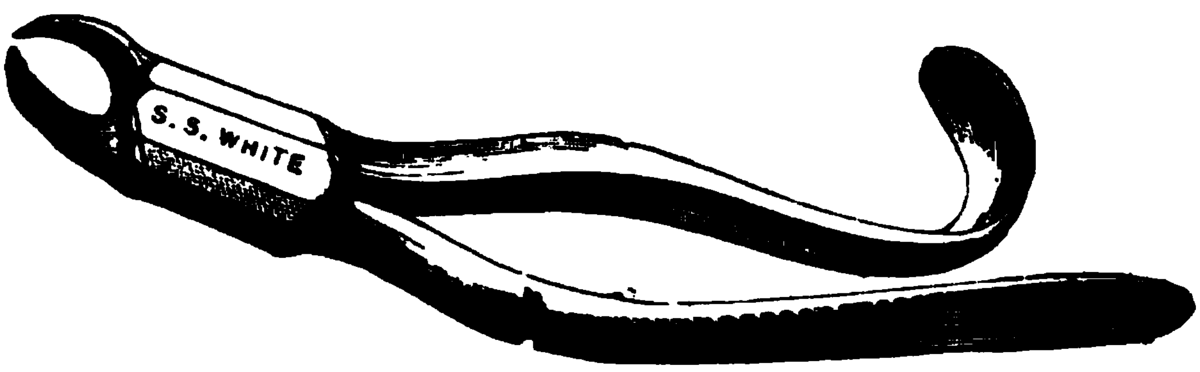
FIG. 521.



this means a sufficiently firm hold is secured to enable the operator to remove the roots of an upper molar without difficulty. Two pairs, as represented in the engraving, one for the right and one for the left side, are required.

Fig. 521 represents a form of forceps recently introduced, which is also used for the extraction of the roots of the superior molars

FIG. 522.



before they have become separated by decay; a right and left are required.

Fig. 522 represents a lower molar cowhorn forceps for either side.

Figs. 523 and 524 represent lower molar cowhorn forceps for the right and left side.

FIG. 523. (*Right Side.*)

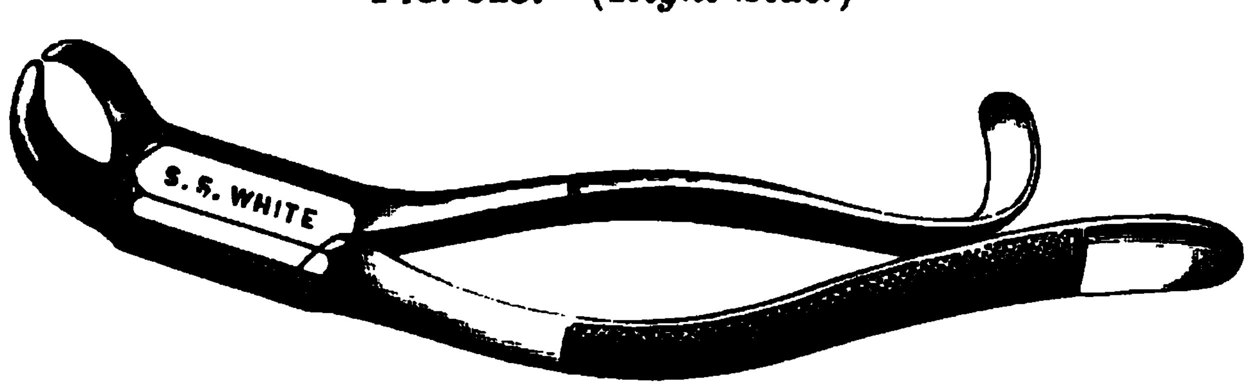
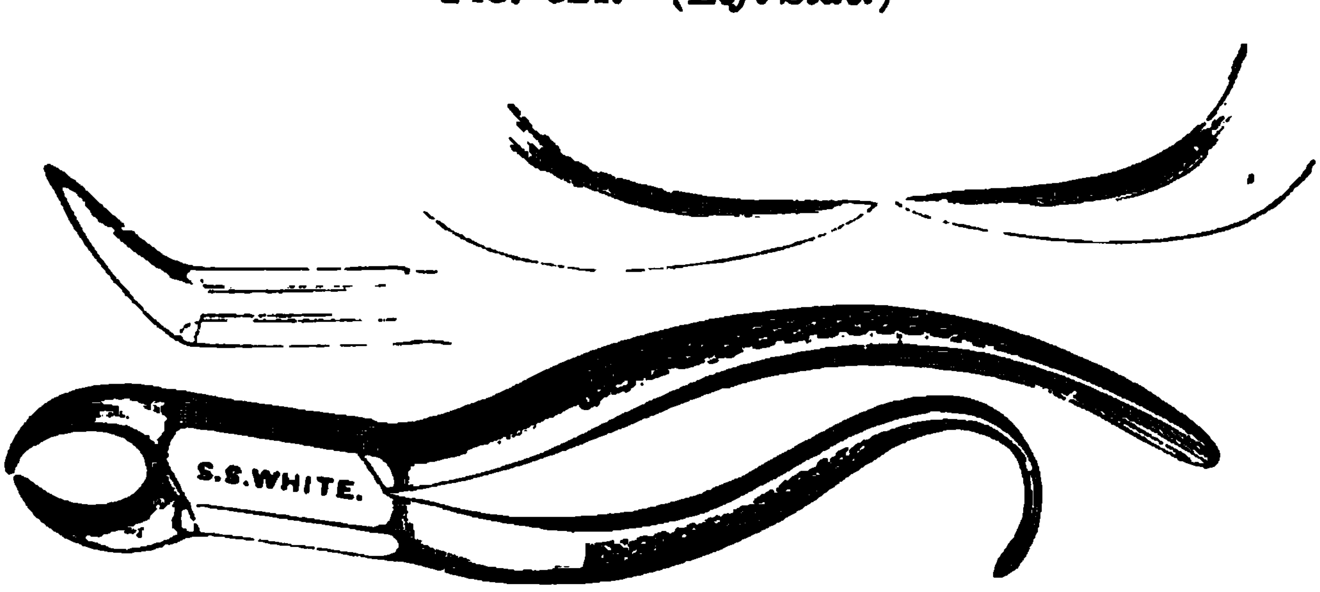


FIG. 524. (*Left Side.*)



The advantage to be derived from forceps of this description must be apparent to every dentist.

Fig. 525 represents Tomes's universal root forceps, which is a very useful form for the extraction of fragments and small roots of teeth.

Fig. 526 represents Arrington's bayonet-shape, slender beak for-

ceps for the extraction of difficult roots in upper jaw and roots of front teeth in the lower jaw.

FIG. 525.

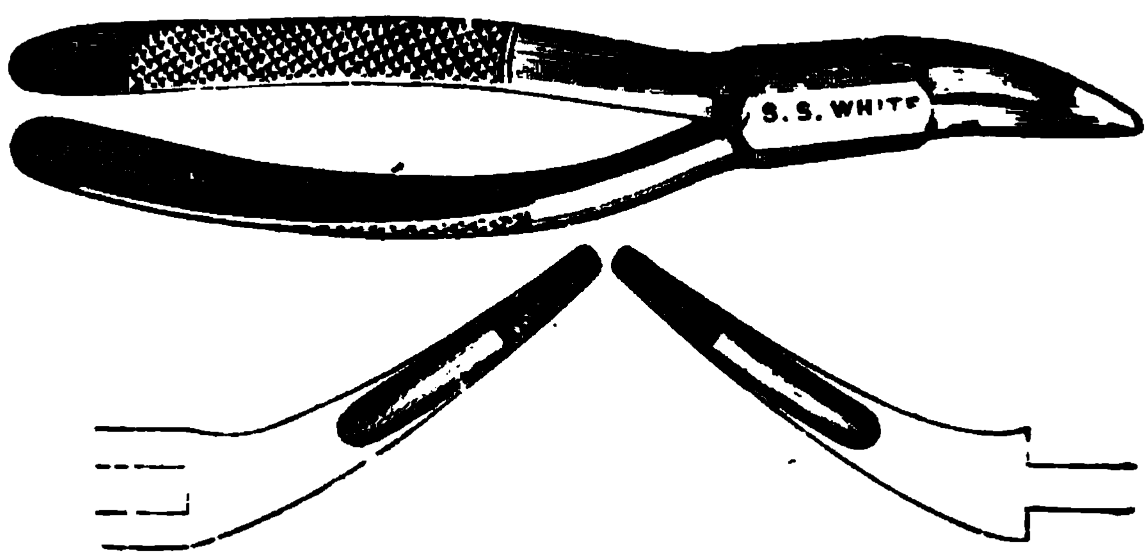


FIG. 526.

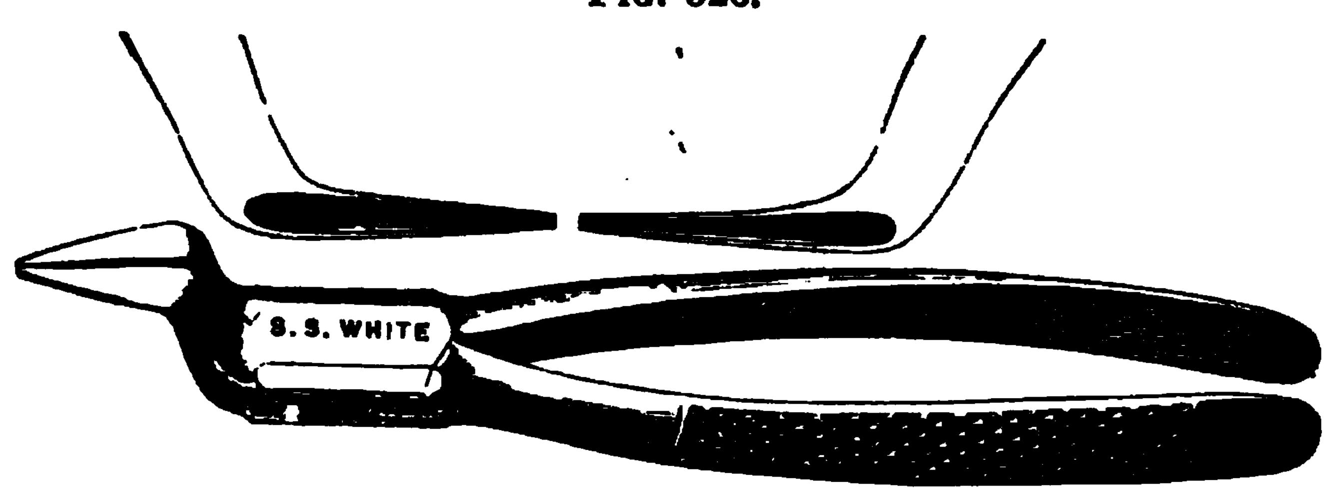


FIG. 527.

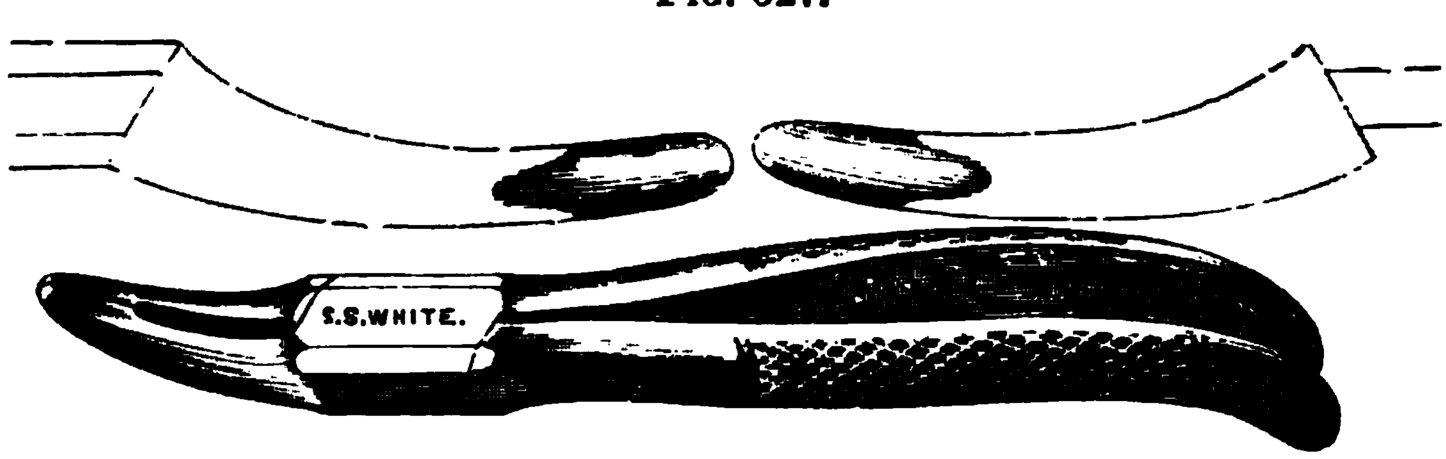
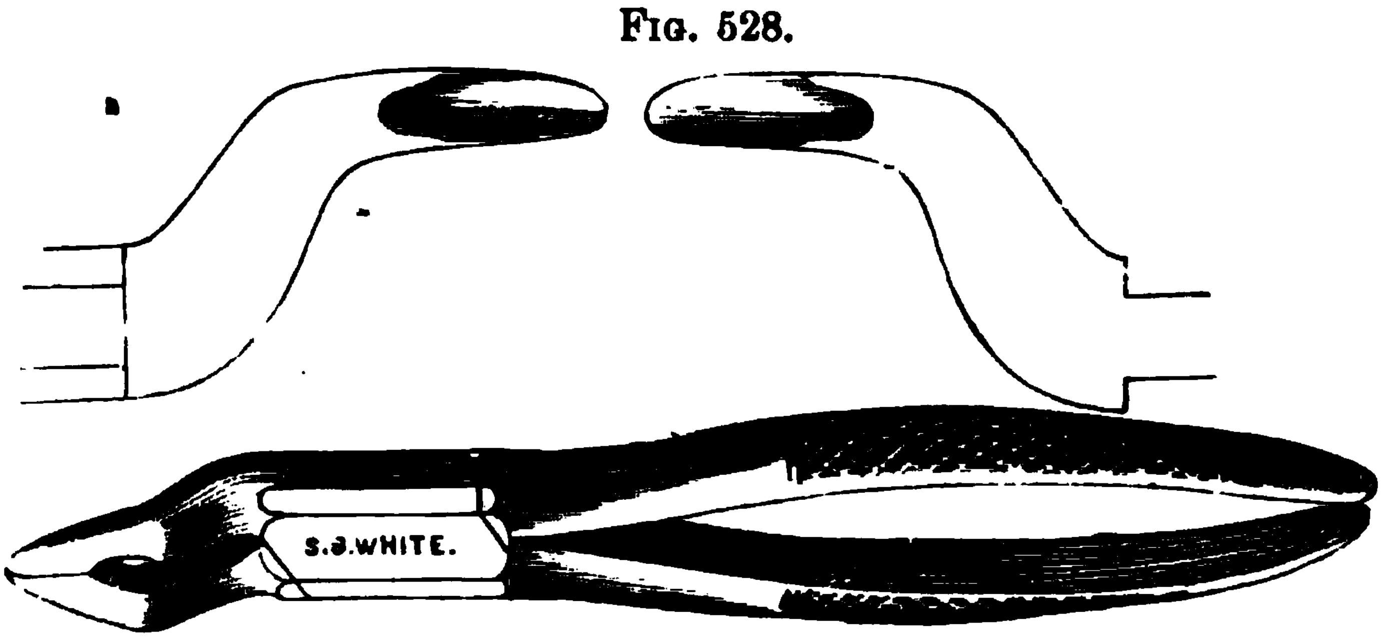


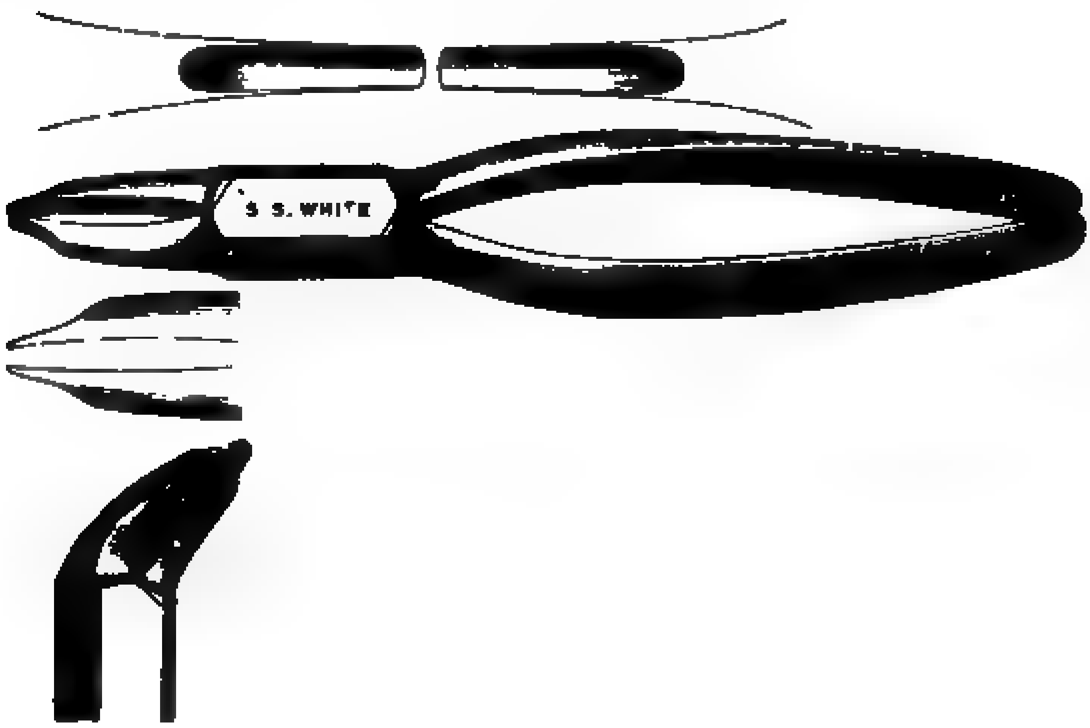
FIG. 528.



Figs. 527 and 528 represent front and back alveolar nipping forceps, for cutting away processes after extraction, and which may also be used for removing roots of teeth.

Fig. 529 represents Tees's sub-alveolar thin-pointed forceps, which are designed to slip within the alveolar process and into the tooth-

FIG. 529.



socket to remove teeth the crowns of which are entirely decayed or broken off.

EXTRACTION OF THE TEMPORARY TEETH.

The temporary teeth should be extracted in the same manner as the permanent and with the same instruments. If the power be properly directed very little force is required for their removal, because the roots of these teeth have generally suffered more loss of substance before the operation is called for; and when they remain, the alveolar processes at this early age are so soft and yielding as to offer little resistance to the tooth.

The operator should be careful not to injure the pulps of the permanent teeth or the jawbone. Serious accidents sometimes occur from an improper or awkward removal of these teeth. But, as has been before remarked, their extraction is seldom required. It should only be resorted to for the relief of toothache, the cure of alveolar abscess, to prevent irregularity in the permanent teeth, or in case of necrosis of the socket. And even in such cases it is necessary to exercise much judgment in deciding how far pain and inconvenience should be endured rather than extract the offending tooth; or how far the chance of injury to the permanent teeth demands the removal of the diseased milk teeth. Their premature

extraction is so often followed by a crowded state of the permanent teeth, that their indiscriminate removal for trifling causes cannot be too strongly condemned.

FIG. 530.

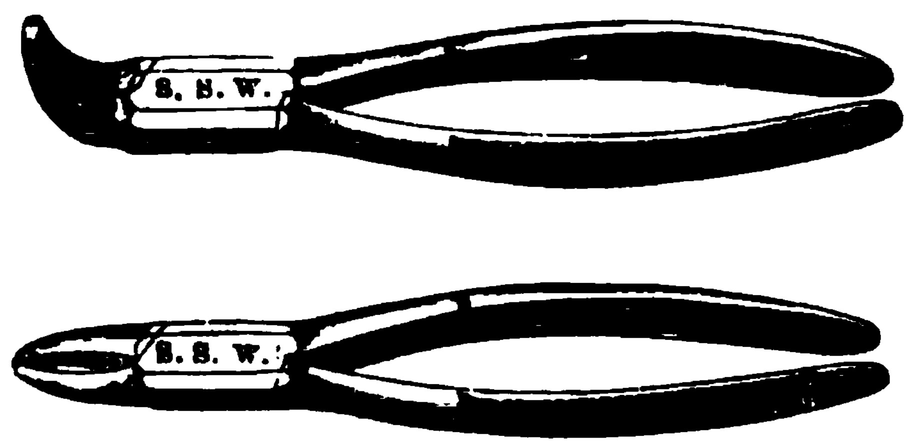


Fig. 530 represents forceps, curved and straight, for the extraction of children's teeth.

FIG. 531.

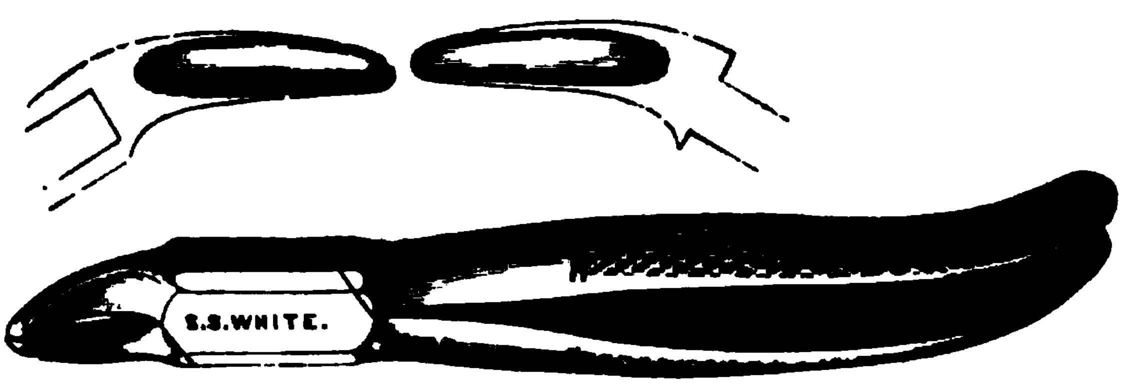


Fig. 531 represents forceps for the extraction of children's teeth, and which will also answer as universal root forceps.

HEMORRHAGE AFTER EXTRACTION.

It rarely happens that excessive hemorrhage follows the extraction of a tooth. Indeed, it is oftener more desirable to promote bleeding by rinsing the mouth with warm water than to attempt its suppression, especially after the extraction of teeth affected with periodontitis, as such hemorrhage relieves the congestion of the parts and hastens recovery. Nevertheless, cases do sometimes occur in which it becomes excessive and alarming. It has been known in some instances to terminate fatally; this, however, does not appear to be dependent upon the manner in which the operation is performed, but rather upon a hemorrhagic diathesis of body, attributable to a deficiency in the coagulating property of the blood, a defibrinating condition, or hereditary predisposition. Hence, whenever a tendency to it exhibits itself in one member of a family, it is usually found to exist in all.

There are two forms of hemorrhage—the "primary," which immediately follows the extraction of a tooth, and the "secondary,"

which occurs after the arrest of the primary. A patient may have a tooth extracted during the day and no unusual hemorrhage result, which is the common experience; but during the night or the next day, or even later, a serious flow of blood may ensue, which is secondary hemorrhage and much more difficult to arrest than the primary form. Of the many cases which have fallen under our own observation we shall mention only the following:—

In the fall of 1834 Miss I., fifteen years of age, had the second molar on the left side of the upper jaw removed. The hemorrhage immediately after the operation was not greater than usually occurs, and in the course of half or three-quarters of an hour it ceased altogether. But at about twelve o'clock on the following night it commenced again, the blood flowing so profusely as to excite considerable alarm. A messenger was immediately sent to ask our advice, and we directed that the alveolar cavities should be filled with pledgets of lint, saturated with tincture of nutgalls. Two days after, at about six o'clock in the morning, we were hastily sent for by the young lady's mother, and when we arrived at her residence we were informed that the bleeding had been going on for about four hours. During this time more than two quarts of blood had been discharged. The blood was still oozing very fast. After we had removed the coagulum we filled the socket with pieces of sponge, saturated, as the lint had been, with tincture of nutgalls. When firmly pressed in and secured by a compress, the hemorrhage ceased. These were permitted to remain until they were expelled by the suppurative and granulating processes. We afterward had occasion to extract one tooth for a sister and two for the mother of the young lady, and a hemorrhage similar to that just described occurred in each case. Where the tendency to hemorrhage exists, due care should be exercised, immediately after the extraction of teeth, to guard against its occurrence by the application of a reliable styptic. Some of the more simple local remedies for its arrest are spider-web as a mechanical obstructor; also compressed sponge saturated with sandarac varnish or coated with soft wax; the return of single-root teeth, coated with wax, to the cavity; the lint of black silk, owing to the efficacy of the coloring matter; the scrapings of leather, on account of the tannin used in preparing it; lint of old linen, saturated with phenol sodique, all of which may be packed into a bleeding cavity after freeing it from blood, and kept in place, if necessary, by a compress; also the adaptation of a rubber plate accurately to the part, or of modeling composition as compresses for the retention of the styptic; also alum; also matico leaf, prepared by immersing a piece in water for a few minutes and rolling it into pellets, or into a

cone, with the under surface of the leaf outward, and packing these into the cavity, after which a compress is applied, and also a bandage round the head and under the chin to keep the mouth at rest. The more powerful styptics for local application consist of tannic acid, gallic acid, nitrate of silver, tincture perchloride of iron, solution of persulphate of iron, powdered subsulphate of iron. Tannin is an excellent styptic, and answers well in connection with the compress of lint or cotton in most cases, also gallic acid, and their clots are not soluble in the blood. The tincture perchloride of iron and the solution persulphate of iron, although powerful styptics, are not reliable, on account of the danger of sloughing and the occurrence of secondary hemorrhage. The same is the case with the nitrate of silver, the use of which, although it may prove successful in some cases, is attended with destruction of tissue, and its clot is soluble in the blood. The powdered subsulphate of iron (Monsel's) applied to the bleeding cavity on pledgets of cotton saturated with sandarac varnish, with a compress so adjusted as to act directly upon the mouth of the bleeding vessel, will generally prove effectual in arresting alveolar hemorrhage. The compression should be moderate, and the packing be allowed to remain until all danger of a return of the bleeding is past. In many cases of severe alveolar hemorrhage it is better to allow the packing to come away of itself. Constitutional treatment is frequently necessary in connection with the local treatment, and such internal remedies as acetate of lead, two grains; opium, one grain; tincture of perchloride of iron, ♏xv–xxx; gallic acid, gr. v–x; tincture of erigeron canadensis, gtt. j, every minute; dilute hydrochloric acid, gtt. xv in a wineglass of water every four hours, will prove serviceable in obstinate and severe cases. Veratrum viride, in doses of gtt. v to water ℥ss, will depress the action of the heart, and, as a consequence, prove beneficial. Rest, and the horizontal position, with the head and shoulders raised, are valuable adjuncts to the treatment. In some cases it may be found necessary to have recourse to the actual cautery.

The following case is quoted by Dr. Fitch from "Le Dentiste Observateur, par H. G. Courtois," Paris, 1775:—

"A person living in Paris called on me to extract a canine tooth for him. On examining his mouth I thought that the man was attacked with scurvy; but this did not seem sufficient to hinder the patient from having his tooth extracted; nor would he consent to its remaining, on account of the pain which it gave him. After the tooth was extracted it did not appear to me that it bled more profusely than is customary after similar operations. The following night I was called upon to see the patient, who had continued to

bleed ever since he left me. I employed, for stopping the hemorrhage, agaric from the oak bark, which I commonly used with success. The following day I was again sent for; the bleeding still continued. After having disburdened the mouth of all the lint-pledgets, which I used for making compression at the place where the blood appeared to come from, I made the patient take some mouthfuls of water to clear his mouth of all the clots of blood with which it was filled; I perceived then that the blood came no longer from the place where I had extracted the tooth, but from the gums; there was not a single place in the whole mouth from which the blood did not issue. I called in the physician, who ordered several bleedings in succession, besides astringents, taken internally, and gargles of the same nature; but all these attempts to improve the coagulability of the blood were made to no purpose. It was not possible to stop the hemorrhage. The patient died the ninth or tenth day after the extraction of the tooth."

The late Professor Gross was the first to call attention to a form of neuralgia occurring after the extraction of teeth, and depending upon thickening and induration of the alveolar margin, by which the remains of the dental nerves after the removal of teeth become compressed and irritated. The treatment in such cases consists in the removal of the margin of the alveolus compressing the nerve with cutting forceps, and thus freeing the irritated tissue.

CHAPTER VI.

THE USE OF ANÆSTHETIC AGENTS IN THE EXTRACTION OF TEETH.

Of the various agents that have been employed for the prevention of pain during surgical operations, sulphuric ether and chloroform have proven more successful and been more generally used than any others. The practicability of producing anæsthesia with ether was first demonstrated by Dr. Horace Wells, of Hartford, Conn., in 1846, and soon afterward brought prominently before the medical and dental professions by Dr. W. G. S. Morton, of Boston, Mass., both practical dentists; and with chloroform, in 1847, by Prof. J. Y. Simpson, of Edinburgh, Scotland. The anæsthetic effect is obtained by inhalation of the vapor, and is supposed to be nothing more than a transient state of intoxication, which usually disappears almost immediately after the discontinuance of the administration,

though in many cases it has proved fatal. For this reason we do not think that agents capable of producing such powerful and dangerous effects as ether and chloroform should be used in so simple an operation as the extraction of a tooth. The first, however, is less dangerous than the second; but its anæsthetic effect is less certain and prompt, from seven to ten minutes being usually required, whereas, with the other, it is obtained in from thirty seconds to two minutes. When ether is used, from six to ten or fifteen ounces are employed; but with chloroform it is rarely necessary to administer more than from thirty to one hundred and fifty drops. What we have said about sulphuric ether applies equally to chloric ether, a substance very extensively used, if not first proposed, by the late Prof. Warren, of Boston.

A number of instruments have been devised for the inhalation of the vapor of these agents; but the simplest and, we think, the best method of administration is from a hollow sponge, a napkin, or a pocket handkerchief.

It may not always be possible for any one, in the administration of either of the foregoing agents, even to a person supposed to be free from any special proclivity to disease from organic derangement, to pronounce, *à priori*, that no bad effect will result from it; but all agree that it is unsafe to give it to a patient laboring under disease of the heart, brain, or lungs. The practitioner, therefore, whether medical or dental, should be well assured, before giving ether or chloroform, and especially the latter, that these organs are not only free from disease, but also from any morbid tendency, as ignorance with regard to this matter might lead to fatal consequences. It should be given cautiously under any circumstances, and the pulse should never be permitted to fall, during the inhalation, below sixty, or, at most, fifty-five beats a minute; but if, from carelessness or any other cause, the patient should sink and the pulsation cease, the agent should be immediately removed from the mouth, and if occupying a sitting posture he should be placed in a reclining position, air freely admitted, cold water dashed in the face, the feet and hands rubbed with hot salt or mustard, and, if necessary, artificial respiration made and galvanism applied. In addition to these means the tongue should be depressed and drawn forward by a finger thrust deeply into the mouth, as recommended by Ricord; or Marshall Hall's or Sylvester's methods may be faithfully and patiently practiced. Ellis gives the following simplified formula of his method for cases of asphyxia from drowning: "Instantly place the patient on the face and side, supporting the head. Unfasten the clothes about the neck and chest, braces, etc. Wipe and clean the

mouth and nostrils. Raise and support the chest on a folded coat or bundle. Roll the patient constantly and gently from the face to the side, and back again, occasionally changing the side, supporting the head. On the completion of each turn to the face make a brisk pressure on the back, between and below each shoulder blade. Dry and rub the patient briskly, rubbing upward."

The inversion of the body, a method devised by the celebrated French surgeon Nélaton, has been resorted to successfully. Nitrite of amyl, a powerful stimulant, has been successfully inhaled in cases of chloroform narcosis with dangerous symptoms, but care is necessary in its use; and not more than ♏ij should be administered by inhalation to persons unaccustomed to its effects.

It is thought by those who have had most experience in the use of ether and chloroform as anæsthetic agents that their administration is attended with less danger when the patient is in a reclining than when in a sitting posture. It would be well, therefore, when ether is used preparatory to the extraction of teeth, to place the patient as nearly as possible in such a position; when the dentist is provided with an operating chair having a movable back, this can be very readily done.

Nitrous Oxide Gas is more generally employed as an anæsthetic in the practice of dentistry than any other, and the immunity from accident with which it is administered is an evidence of its safety when compared with chloroform and other general anæsthetics; due care, however, should be exercised in the use of all general anæsthetics.

The anæsthetic effect of nitrous oxide, or laughing gas, was first suggested by Sir Humphry Davy, in 1776, and practically demonstrated by Dr. Horace Wells. This gas is manufactured from the salt nitrate of ammonia, either in a fused or granulated form, by slowly melting and boiling it in a glass retort, over a sand bath, until nearly all of the nitrate is decomposed. The gas, on leaving the retort, passes through several wash bottles, one of which contains either a solution of the sulphate of iron or caustic potash, and the other two pure water, for the purpose of purifying it before it enters a holder and receiver, from which it is administered to the patient by means of an inhaling tube. One pound of the granulated nitrate of ammonia will produce about thirty gallons of the gas, which should be administered to the patient in a pure state—unmixed with atmospheric air.

Fig. 532 represents an apparatus for generating nitrous oxide gas.

Liquefied Nitrous Oxide is, however, a more convenient form for use. To obtain this form the nitrous oxide gas, after being sub-

jected to intense cold and pressure, is condensed in the form of a liquid, in a strong iron cylinder, one hundred gallons of the gas weighing but ten pounds, and capable of being condensed into a cylinder.

Fig. 582.

Fig. 583 represents Downs' stand for gas cylinders, for use in the operating room.

Fig. 584 represents an upright Surgeon's Case, of a convenient and sightly form, with bag and inhaler attached.

Fig. 585 represents an improved inhaler, for either gas or ether;

when it is desired to administer ether, the end tube, to which the rubber tubing is connected, can be unscrewed, and the globe, which contains a sponge to hold the ether, attached in its stead.

In administering this gas for dental operations, the patient is seated in an operating chair with a movable back, a cork or piece of wood to which a string is attached placed between the jaws, or, what is better, Bickfort's mouth prop, which is in the form of a telescope slide with blocks of rubber at the ends to act as cushions to protect the

FIG. 538.

teeth (Fig. 536), and the mouth-piece of the inhaler between the lips, which he is directed to close tightly around it. The operator, who occupies a position on the right side of the patient, supports the inhaler with his right hand, some of the fingers of which press the lower lip tightly about the mouth-piece. The thumb and index finger of the left hand close the nostrils, while the remaining fingers press the upper lip about the mouth-piece of the inhaler. The pa-

tient is then instructed to make long but at the same time natural inspirations, one of the valves of the inhaler permitting the exhalations to pass off.

After thus inhaling the gas for a few minutes, its anæsthetic effects are shown by strong involuntary respirations attended by a snoring sound, owing to the relaxation of the muscles of the pharynx. Then follows a livid appearance of the lips, from the discolored blood in the capillaries. A spasmodic twitching of the muscles is observed at this

FIG. 584.

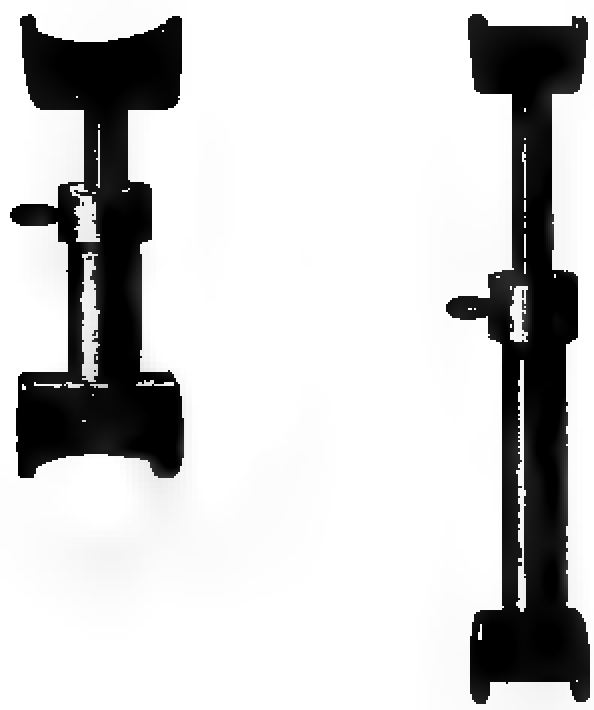
stage in many patients, when complete narcosis follows. The narcotic effects of the gas continue from thirty seconds to one and a half minutes, and the number of teeth which can be extracted varies from four to twelve. It is of no unusual occurrence, however, for the extraction of one tooth to consume the entire time the patient is under the narcotic influence of the gas, while in other cases more than the highest number just mentioned may be removed before the patient becomes conscious of pain.

Nitrous oxide gas is considered to be the safest general anæsthetic now in use, and does not produce the nauseating and debilitating effects which are often caused by ether and chloroform. Extreme caution, however, is necessary in administering this gas under circumstances which prohibit the use of other general anæsthetic

agents. The greatest objection to its use, aside from the question of safety, is the rapidity in operating which its transient effect necessitates; and it is much better to carefully extract a few teeth

FIG. 535.

FIG. 536.



than to attempt the removal of many by an operation which may be attended with severe laceration of the gums and fracture of the alveolus.

Bromide of Ethyl.—Hydrobromic ether is obtained from bromide of potassium, sulphuric ether, by distillation, and by re-distillation with chloride of lime. Although a pleasant anæsthetic and very prompt in its effect, yet its administration is not without danger, and hence caution is necessary in its employment. It is administered in the same manner as ether or chloroform, and recovery from its influence is more rapid than with either of these agents. From thirty seconds to five minutes are required to manifest its anæsthetic effects. The quantity required differs, according to the susceptibility of the patient, the usual rule being to commence with one drachm, then administer a second, and if necessary a third drachm may be inhaled in two minutes after the administration of the second drachm. Two drachms will, however, in most cases, be sufficient to cause profound anæsthesia.

Dr. B. W. Richardson, of London, introduced an anæsthetic agent known as the *bichloride of methylene*, which is formed by the action of sulphuric acid on zinc in chloroform. It differs, however, from chloroform, in the circumstance that one atom of chlorine is replaced by one atom of hydrogen. Bichloride of methylene produces as great a degree of insensibility as chloroform, and its action is more rapid and the narcotism very prolonged. It also interferes less with muscular irritability than either ether or chloroform, and the recovery from its effects is sudden; but more of it is required. When it destroys life, as it has in several cases, the respiring and circulating functions are equally paralyzed.

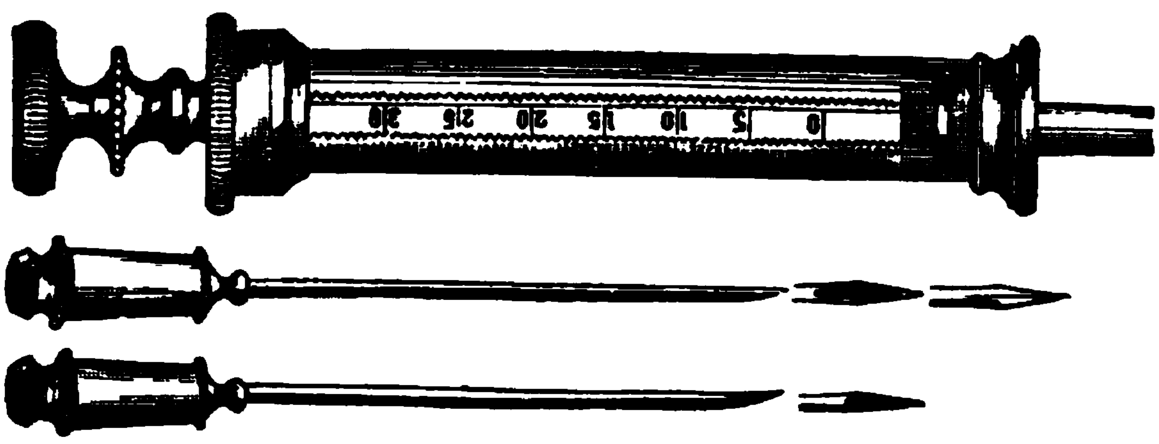
Hydrate of chloral is another general anæsthetic agent which has been extensively employed. Chloral is by no means a new anæsthetic, Liebig having discovered it in 1830; but, as Dr. B. W. Richardson states, the introduction of it into medicine is a fact of the year 1871, its introducer being Liebreich, of Berlin.

The hydrate is made from the chloral by the simple addition of a little water, and on the application of heat solidifies into a white crystalline substance.

The manner in which hydrate of chloral is administered is in solution with water, either by the mouth directly into the stomach, or by subcutaneous injection. The best solution is made by mixing one grain of the hydrate with two of water. Dissolved in an excess of water, the taste is agreeable, with the odor of a ripe melon. It is administered to human subjects in doses varying from twenty-five to thirty grains, causing unconsciousness to pain and a profound sleep lasting over several hours. The sleep is gentle and quiet, induced without distress, and leaving no other symptom behind except nausea, which is occasionally experienced after re-

covery. In administering this agent, it appears to act more promptly when subcutaneously injected than when administered directly by the mouth; and as chloral dissolved in water is slightly caustic, it cannot be administered by the mouth when there are lesions of mucous membrane or ulcerated tracts of intestinal canal. In administering hydrate of chloral to the human subject, Dr. Richardson states that allowance will have to be made, not only in

FIG. 537.



relation to size and weight, but to obesity or leanness, to natural habit and actual state of body in respect to sensibility.

Fig. 537 represents the full size of a hypodermic syringe with graduated rod and steel points.

Local Anæsthetics.—Suspension of nervous sensibility induced by inhaling the vapor of ether, chloroform, nitrous oxide, bromide of ethyl, etc., is general, every part of the body being affected alike; but partial or local anæsthesia may be procured by other and less dangerous means. Congelation or freezing, first proposed and employed in the Charité Hospital, Paris, by an *interne* of M. Velpeau, and subsequently recommended by Dr. James Arnott, of London, was formerly resorted to both by surgeons and dentists, and practiced to a limited extent with success. This may be effected by applying a mixture of pounded ice and common salt, in the proportion of two or three parts of the former to one of the latter, to the part on which the operation is to be performed. But in the use of this care is necessary to prevent reducing the temperature too much, as in this case loss of vitality would be occasioned by it. We have heard of a few cases in which this has occurred, but we believe it was owing in every instance to carelessness or want of judgment on the part of the operator as to the length of time the application of the mixture should be continued.

Several instruments have been invented for the application of the freezing mixture to teeth preparatory to extraction. The one best adapted for the purpose was designed by Dr. Branch, of Chicago, Ill. It consists of a hollow tube about an inch or a little more in

diameter, with about five-eighths of an inch cut out at one end, on either side, that it may readily be passed over a tooth. To this is attached a sac of finely prepared membrane, large enough to hold a tablespoonful of the mixture. The hollow of the tube is occupied by a steel wire spiral spring. Just before using it, a sufficient quantity of the freezing mixture is put in the tube; the end of the latter is placed over the tooth, when the ice and salt are forced up gently around it by pressing on the spring at the other extremity of the instrument. Two tubes are employed, one straight, for teeth in the anterior part of the mouth, the other bent near one end for the more convenient application of the mixture to a molar tooth.

The sudden application of such intense cold to a sensitive tooth, or to one which has not lost its vitality, is often productive at first of severe pain; on this account many object to the use of it, preferring the momentary suffering consequent upon the operation of extraction rather than that occasioned by the freezing mixture. But this effect is rarely experienced in its use on dead teeth, or the roots of teeth which have lost their vitality; hence, the application of it has to such proved more satisfactory than to living teeth.

With the view of obviating the above objection to the use of cold as an anæsthetic agent, Messrs. Horne and Thornthwaite, opticians, at the suggestion of Mr. Blundell, dentist, of London, contrived and constructed an apparatus by which the temperature may be gradually diminished, say from 98°, or blood-heat, down to zero, or any required degree, thus preventing the pain consequent upon the sudden application of the freezing agent. The apparatus is thus described: "The required amount of water is cooled down, by means of ice and salt, to about zero, in a vessel called the refrigerator. To this vessel is attached another called a graduator, containing warm water at about 100°, and so constructed as to allow the slow admixture of its contents with the chilled water in the refrigerator, and thus producing a gradually diminishing temperature for the purpose of preventing sudden shock and pain to the teeth, which a direct application of cold would inevitably cause. A tube conveys this graduating current into a terminal portion, constructed of very fine membrane, which adapts itself to the form of the gums and wholly surrounds the tooth to be withdrawn. The fluid then passes away through an exit tube. In this manner a constant current of cold at a decreasing temperature is made to pass over the part, abstracting therefrom all heat, and with it the power of feeling." The gum and alveolar membrane being now in a frozen condition, and, consequently, devoid of sensibility, the extracting instrument is applied and the tooth removed.

In the year 1858, Mr. J. B. Francis, dentist, of Philadelphia, announced the discovery of an original method of producing local anæsthesia, said to be peculiarly applicable to the extraction of teeth, which consists in passing an electro-galvanic current through the tooth at the moment of its removal. The discovery was submitted to the Franklin Institute, Philadelphia, and the committee to whom it was referred for examination, composed in part of dentists, reported favorably in regard to the claims of the inventor.* One of the members of the committee, W. S. Wilkinson, states that he had extracted between four and five hundred teeth, applying the electric current, and that in ninety-five per cent. of the cases it was done without pain to his patient.

The method of applying it is very simple. One pole (the negative is preferable) of the electro-galvanic machine is attached to one of the handles of the forceps by means of a flexible conductor, while the metallic handle of the other is grasped by the patient, the power of the current being, previously to the operation, graduated by the piston of the coil, while the patient holds the forceps in the other hand. The current should only be sufficiently powerful to be distinctly felt. The circuit through the tooth is not made until at the instant the operation begins. The closing and breaking of the galvanic circuit is managed either by the foot of the operator or by an assistant.

A small electro-galvanic battery, arranged for this purpose, having been placed in the office of the author soon after the announcement of the discovery, he has had frequent opportunities of applying this new agent in the extraction of teeth. Thus far, about nine out of ten of those who were placed under its influence while undergoing the operation assured him that they either experienced no pain at

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* The following is an extract from the report referred to above: "The committee is satisfied, from the observation and experiment of its members, that in a large majority of cases of extraction with this apparatus, *no pain whatever* is felt by the patient.

"To test the question whether the effect might not be simply mental, the circuit was broken without the patient being aware of it, when the usual pain was experienced, although in the same patient, and on the same occasion, teeth had been removed, while the current was flowing, without causing pain.

"In the less successful cases the teeth were broken and diseased below the level of the gum, and the pain in adjusting the forceps, previous to the completion of the circuit and the extraction, was considerable.

"The sensation produced by the passage of the current is not painful, it being so adjusted as to be *just perceptible* to the patient. The committee believes its use to be entirely without danger, and not likely to be followed by any unpleasant after effects."

all or only very little—not a tenth part of what they had experienced under the operation on former occasions. In almost every case in which the tooth was grasped, allowing the instrument to come in contact with only the edge of the gum, the operation appeared to be painless, or nearly so. But when pushed up a considerable distance between it and the tooth the suffering was not appreciably diminished, the electric current in such cases seeming to be too much diffused. It is stated by those who have made the experiment that this diffusion of the electric current may be prevented by insulating the outer portion of the instrument with a coating of gutta-percha, or by japanning. The author has not tried this expedient.

How it is that the passage of an electric current through a tooth should prevent pain may be explained by supposing the subtle fluid to exhaust the sensibility of the nerves of the parts comprised in the operation; and that it does, in a majority of cases, is attested by many who have been placed under its influence. It may be nothing more than a mere substitution of one sensation for another; but whether its application will become general, or its efficacy as an anæsthetic agent be fully established, remains for future experience to settle.

The experience of the profession may be briefly summed up thus: In one-fourth the cases it relieves or neutralizes the peculiar pain of extraction, in one-half it has but little effect, and in the remaining fourth it very decidedly aggravates the pain. It has, however, the advantage over chloroform and the freezing process of being without any serious sequelæ.

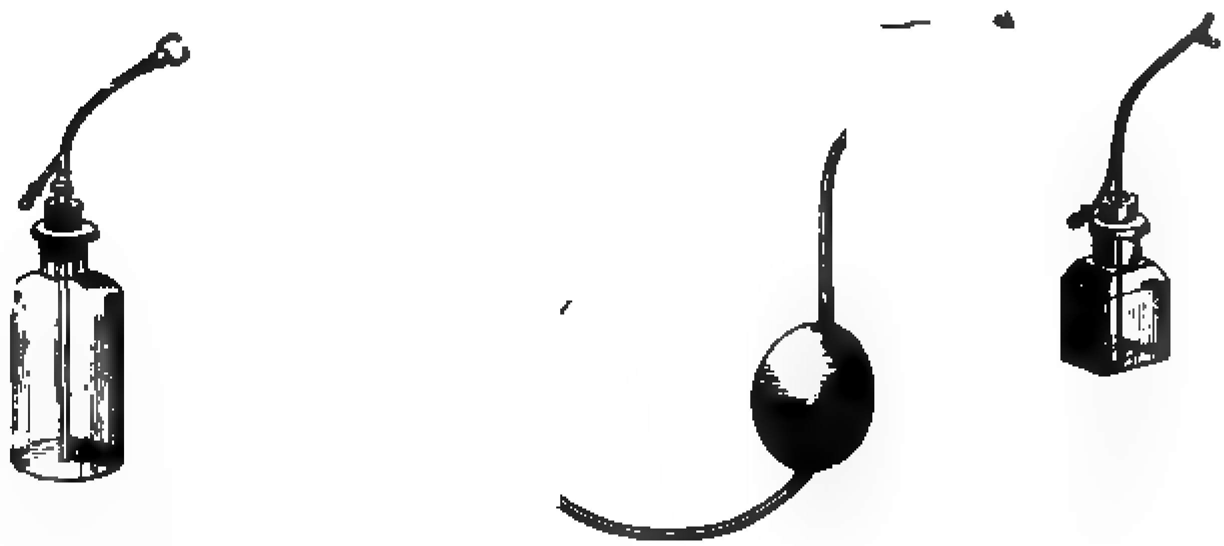
"Voltaic narcotism" is a term applied by Dr. B. W. Richardson to a method of local anæsthesia in which the galvanic current is passed through a narcotic solution placed in contact with the part to be operated upon. Dr. Richardson claims that by such a method complete local anæsthesia can be produced by solutions of narcotic agents which are inert when applied without the galvanic current. While this method may be used with satisfactory results in cases where the cavity of the tooth is exposed, it has never come into general use.

Dr. B. W. Richardson also introduced a much more speedy and effectual method of congelation than those before described, by taking advantage of the intense cold occasioned by the rapid evaporation of ether spray when forced through one of the instruments invented for the atomization of fluids.

"The principle," Dr. Richardson remarks, "consists in directing on a part of the body a volatile liquid, having a boiling point at or

below blood heat, in a state of fine subdivision or spray, such subdivision being produced by the action of air or other gaseous substance on the volatile liquid to be dispersed. When the volatile fluid, dispersed in the form of spray, falls on the human body, it comes with force into the most minute contact with the surface upon which it strikes. As a result there is rapid evaporation of the volatile fluid, and so great an evolution of heat force from the surface of the body struck, that the blood cannot supply the equivalent loss. The part, consequently, dies for the moment, and is insensible, as in death; but as the *vis a-tergo* of the body is unaffected, the blood, as soon as the external reducing agency is withdrawn, quickly

FIG. 538.



makes its way again through the dead parts, and restoration is immediate. The extreme rapidity of the action of this deadening process is the cause of its safety."

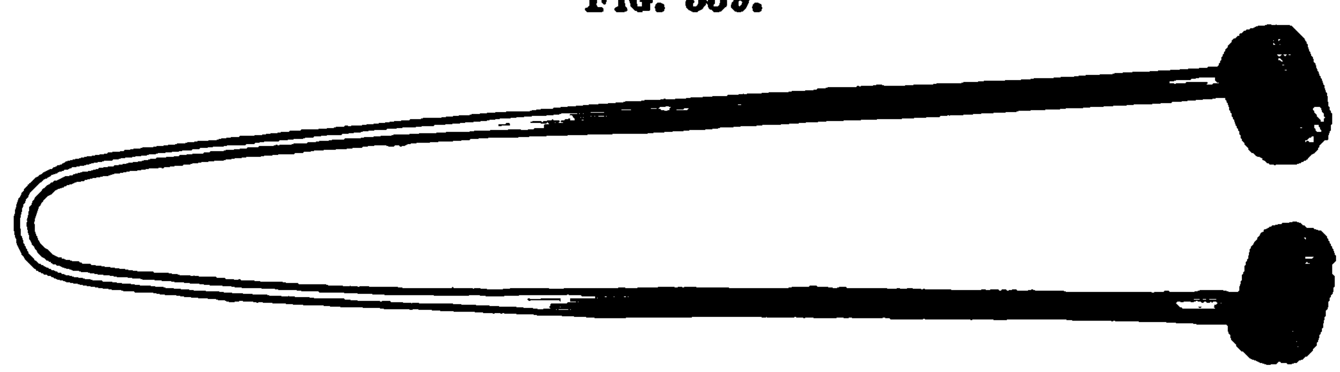
Fig. 538 represents the apparatus, which consists of a spray-tube, bottle, and hand-bellows, for producing local anæsthesia by narcotic spray.

Either absolute ether or rhigolene may be employed, both of which are highly inflammable. Some prefer rhigolene on account of its action being more prompt than that of the ether, while others consider the latter more agreeable and easily controlled. To produce the local anæsthetic effect with these agents in the form of spray requires from thirty to sixty seconds. Before the application of the spray the crown of the tooth to be extracted and mucous membrane over the root should be carefully dried, otherwise a film of ice may be formed which will prevent the full influence of the agent, such as is shown by the blanching of the gum.

Local bloodletting, such as follows lancing of the gums, prior to the application of the spray is said to prevent desquamation.

Obtunding mixtures, consisting of a combination of pyrethrum, aconite, chloral, veratria, and alcohol; or chloroform, aconite, belladonna, and opium, have been employed to produce local anæsthesia, and in many cases with satisfactory results. For although entire insensibility to pain cannot in all cases be brought about, yet some diminution of it may be effected by the use of such agents. They have the merit, at least, of being less dangerous than the general anæsthetics. Such pain-obtunding mixtures are best applied to the parts about the neck and over the root of a tooth by means of a simple apparatus devised by Von Bonhorst. It consists of two small metallic cups attached to the free ends of a spring some seven inches long, and which contain sponges to hold the liquid. (Fig. 539.)

FIG. 539.



When used, the sponges in the cup are saturated with the obtunding mixture and applied by pressing them on the gum on each side of the tooth to be removed, where they are retained from one-half to two minutes. Previous to the application the patient should be cautioned against swallowing any portion of the mixture.

A local anæsthetic known as cocaine has been recently discovered and applied in Germany, with astonishing and satisfactory results, in operations upon the eye. Professor Gorgas has experimented with this new anæsthetic in cases of sensitive dentine and the extirpation of the pulps of teeth by the surgical method, with satisfactory results in teeth of a loose structure. The four or five per cent. solution, the former made with f ℥j of distilled water and 2½ grains of Merck's hydrochlorate of cocaine, may be used, a drop of the solution being applied to the sensitive surface three times, at intervals, during a period of ten or fifteen minutes; at the end of twenty-five minutes a condition of anæsthesia is caused.

The unsatisfactory results from the use of cocaine as a local anæsthetic for the extraction of teeth, owing to the dense and impermeable character of the gum-tissues, when the agent is applied directly to the mucous membrane, led to its application by injection with the hypodermic syringe, represented by Fig. 537, either deeply into the gum-tissues, or to a point as near as possible to the main branches of nerves supplying the teeth with sensation. For inject-

ing the cocaine deeply into the gum-tissues, the syringe, which should be an easy-working instrument, is charged with from twelve to fifteen minims of a four or five per cent. solution, and the needle-point introduced through the mucous membrane, so as to inject the solution deeply into the gum-tissues around the tooth to be extracted. To reach the branches of nerves supplying the superior teeth, the needle-point of the syringe is passed through the mucous membrane to a point as close to the infraorbital foramen as is possible, and about eight minims of the cocaine solution injected; for reaching the inferior dental nerve, the needle-point is carried as near the inferior dental foramen as is possible, or, in the case of the front teeth, near to the mental foramen. Dr. Raymond recommends mixing the soluble alkaloid at the time of using it, taking care to exhaust the air from the syringe when charged ready for use, which may be done by drawing in more of the solution than is needed, and pressing it out to the required number of minims (about eight), and then to hold the needle-point up so as to allow the air to get above the solution, when the piston should be pressed.

"The Herbst Obtundent" consists of a saturated solution of hydrochlorate of cocaine in chemically pure sulphuric acid to which a solution of sulphuric ether is added to the point of saturation, the excess of ether evaporating from the surface on which it floats. About 70 grains of the cocaine hydrochlorate are required to saturate two drachms of the sulphuric acid. Several applications are required to produce the anæsthetic effect.

Cocaine is the alkaloid of the leaves of the *Erythroxylon coca*, a shrub of South America, and has long been used by the natives of Peru and Bolivia as a nerve stimulant. Small animals have been killed by its causing paralysis of the respiratory centres.

Dr. J. A. Robinson has recently suggested carbolized potash (equal parts of caustic potash and carbolic acid) as a local anæsthetic or obtunder in cases of sensitive dentine.

Rapid Breathing as a Pain Obtunder.—The possibility of producing an anæsthetic effect by rapid breathing was suggested by Dr. W. G. A. Bonwill, in 1875. By this method it is claimed that teeth may be extracted without pain. In applying it the patient should rest upon the side and in as reclining a position as is possible to operate. A handkerchief is then placed over the face to insure quiet, and directions are given to breathe rapidly at the rate of about one hundred respirations per minute—blowing-out movement. At the end of from two to five minutes of such rapid breathing it is claimed that an entire, or at least partial, state of anæsthesia results, which may continue for a half or for one or two min-

utes. This method is apparently a harmless one, but some have connected with it such a danger as venous congestion of the brain. Females appear to be more susceptible to this method than males, and children under ten years of age can rarely be induced to breathe properly.

As the use of anæsthetic agents of any kind in the extraction of teeth is attended with inconvenience, nearly always delaying the operation, the author is of the opinion that their employment, as a general thing, should be dispensed with. In the case of females with a highly nervous organization it may now and then be advisable to give a temporary courage to endure pain by the administration of a teaspoonful of brandy. But we have found less trouble with delicate females than with stalwart men; and to the latter we certainly would never advise this use of stimulants. Indeed, the extraction of a tooth is, in the majority of cases, so simple an operation, seldom requiring more than from two to five seconds for its performance, that most persons should rather submit to it at once than have it protracted by the application of an agent for the prevention of the momentary pain which it occasions.

CHAPTER VII.

REPLANTATION, TRANSPLANTATION, AND IMPLANTATION OF TEETH.

Closely connected with the subject of extraction of teeth are Replantation and Transplantation, which appear to have been practiced several centuries ago, both in France and Germany.

Later, both of these operations attracted the attention of John Hunter, in England, and some interesting experiments were made by him in transplanting teeth, although he did not advocate the latter practice.

The operation of "replantation" consists in the return of a tooth to the same cavity from which it has been extracted, and also the necessary antiphlogistic treatment which will result in the re-establishment of the connection which originally existed between the tooth so returned and its cavity. Replantation is performed where a tooth has been accidentally removed, and also for the cure of alveolar abscess, more especially such cases where the extreme end of the root is affected with abscess, and a considerable portion of the investing membrane or periosteum is in a healthy condition. Under such circumstances the operation of replantation may be

performed as follows: The tooth is to be very carefully extracted, and at once placed in warm water, to which a little tincture of iodine has been added. The cavity from which the tooth has been removed should be carefully and gently wiped out with a cone of soft Japanese paper, wrapped about the end of an excavator or other suitable instrument, to remove any shreds of the abscess sac that may remain attached to its walls, and a delicate, spear-shaped nerve instrument passed through the alveolus to detach the cyst. The cavity is then syringed with warm water and packed lightly with cotton saturated with tincture of iodine.

When this is accomplished, attention is again given to the tooth, from which all traces of the abscess sac should be removed, as well as salivary calculus, if present, care being taken, however, not to injure or remove any healthy periosteum that may remain attached to the root. The pulp chamber is then to be exposed, and, with the root canals, thoroughly cleansed and disinfected, and filled to the apex with gold or other suitable material. The packing is then carefully removed from the cavity, which is again syringed with warm water, and the tooth firmly pressed into its former position and held there for a few moments with the fingers. The mouth may then be rinsed with an astringent mouth wash and the tooth secured by ligatures, or, with what answers better, a cap of modeling composition or gutta-percha. The mouth should be rinsed with an astringent wash three or four times daily, and be kept thoroughly clean.

The following mouth washes, from Gorgas's *Dental Medicine*, will prove useful:—

℞.	Acidi carbolici (cryst.),		
	Glycerini and aquæ rosæ, . . āā .	ℨij.	M.

SIG —Five to eight or ten drops in a wineglass of water.

℞.	Tincturæ arnicæ, ...	ℨij	
	Glycerini, ...	ℨij	
	Aquæ rosæ, ...	℥ij	
	Aquæ destillatæ, ...	℥x.	M.

SIG.—To be used as a gargle.

Where the apex of the root of the tooth is necrosed, this portion should be excised and made smooth before the tooth is returned to its cavity, the same treatment as above described being pursued. When a replanted tooth has been returned to its cavity, the lymph present either coagulates and becomes organized, so that no pus is formed, which is the process of healing by "first intention," or the lymph may degenerate into pus, in which latter case the operation

may prove a failure. To obviate such a condition, it has been suggested to make an opening through the alveolus to the apex of the root of the tooth, and, by means of floss silk or a pledget of cotton, to establish a drainage, or to insert a drain tube from the surface of the crown through the canal to the apex of the root.

The operation of "transplantation" consists in the extraction of a tooth from the mouth of one person and transferring it to a cavity in the mouth of another; in some cases the teeth of animals have been substituted for human teeth.

The defective tooth is first extracted, and having previously selected a tooth in the mouth of another, which will correspond in size, color, location, and other characteristics, it is carefully extracted and immediately transferred to the cavity from which the defective tooth has been removed, as soon as the hemorrhage has ceased. When the tooth to be transplanted is of a different form from the one it is to replace, it must be made to correspond to the new cavity by properly changing its dimensions, a procedure that would not be possible, to the same degree at least, in the case of replantation, for many examples are presented of dried teeth having been successfully transplanted. The operation of transplantation is completed by securing the new tooth in position and employing the necessary antiphlogistic treatment, as in replantation. Such teeth, however, never perfectly harmonize with their new relation, and when a dried tooth is used its pulp canal should be previously filled with gold. It is also suggested to excise a portion of the end of the tooth, from one-sixteenth to one-eighth of an inch, and to separate, by a non-conducting substance, the root filling from that in the crown, and, as in the case of replantation, to prescribe an unstimulating diet. In the operation of replantation we depend for success upon a reattachment of the periosteum; but in the case of transplantation, and especially where dried teeth are made use of, stability is due to absorption of the dead tissue on the one hand and a corresponding hypertrophy of living tissue on the other, the root of the tooth undergoing loss of structure in the form of small cavities, and the wall of the alveolar cavity thickened by ossific deposit at points corresponding to the cavities formed in the dead tissue of the root. And while it may require one week for a replanted tooth to become firm, two or more may be necessary in the case of a transplanted tooth. For retaining replanted and transplanted teeth in position, either the modeling composition and gutta-percha splints before alluded to may be employed, or the ingenious device of Dr. Herbst, which is represented by Fig. 235 (p. 434). An interdental splint of either modeling composition or red

gutta-percha, pressed while soft over the newly-placed tooth, and the teeth of both jaws brought in contact and pressed slightly into the plastic mass, will also prove effectual as a retaining appliance.

While the operation of "replantation" is a justifiable one, that of "transplantation" is objectionable for several reasons, namely: the necrosed condition of such a tooth, and, as a consequence, its uncertain duration; the liability to failure; the liability of inoculation by the transmission of disease; and the inhumanity of inflicting loss and pain on one person in order to give another a very uncertain advantage.

An operation known as "implantation" has recently been advocated by Dr. W. J. Younger. It consists in drilling artificial sockets in the maxillary bones, and inserting therein natural teeth of the proper size, shape, and shade, or at least so nearly resembling the shade of the adjoining teeth as devitalized teeth can present. Dr. Younger's method is to carefully dissect from the bone the overlying soft tissues, such as the gum and periosteum, in such a manner as to retain their connection in the form of a continuous flap, so that it may be replaced about the neck of the implanted tooth and assist in securing it. Graded trephines and burrs, operated by the dental engine, are then applied to the maxillary bone, a socket drilled of the size and shape of the tooth to be implanted, which is selected prior to commencing the operation of dissecting the soft tissues.

If the tooth is a recently extracted one (although it is claimed that teeth which have been extracted months previously can be implanted), the pulp is removed and the canal filled with gold at its apex and with gutta percha in the remaining portion. The tooth is then subjected to a solution of bichloride of mercury, two parts to 1000 of water, at the temperature of 110° F. for some fifteen minutes. The instruments employed in the operation are immersed in the bichloride solution, and also the root of the tooth. The artificial socket, which has been prepared in the manner above described, is then carefully cleansed with the same solution, cold water being employed to arrest the hemorrhage, and the tooth placed in position and secured by means of ligatures. The theory upon which Dr. Younger's method is based is that the natural alveolar cavity has no periosteum, and that the formation of these cavities depends upon the thin and delicate membrane lining the cells and interspaces of the osseous structure. He regards the peridental membrane as possessing no "callus generative energy except from its dental aspect;" the other side, he asserts, has the power only of forming attachment. He also claims that the vitality of the peri-

dental membrane is kept up for many months after the extraction of the tooth, and cites examples of teeth having been successfully implanted after they had been extracted for more than a year. The failures attending the operations of replantation and transplantation he ascribes to the existence of disease at the time of treatment, a condition that does not exist when a healthy root is implanted into an artificially formed cavity in the bone.

The records of the cases of implantation, however, do not show that this operation has been to any degree more successful than those of replantation and transplantation; and the failures only prove that physiological law cannot be violated with impunity, as there are certain factors which must not be ignored. The operation of implantation is a most interesting one, as it is novel and unique, and aside from the pain experienced by the patient, one of its

Fig. 540.

TREPHINES.

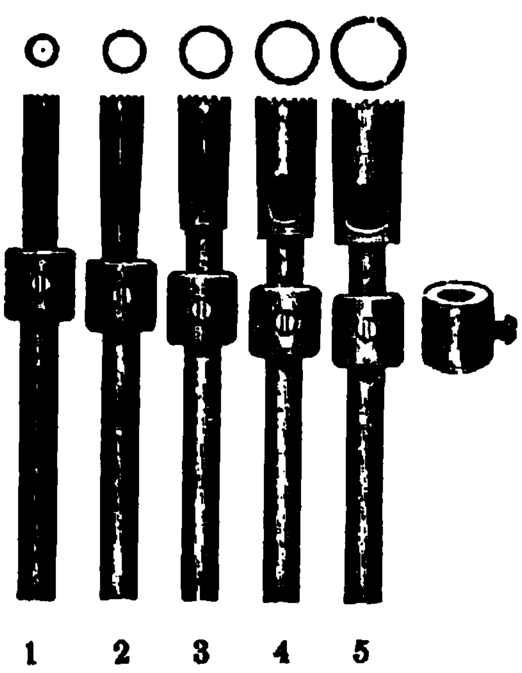


Fig. 541.

REAMERS.

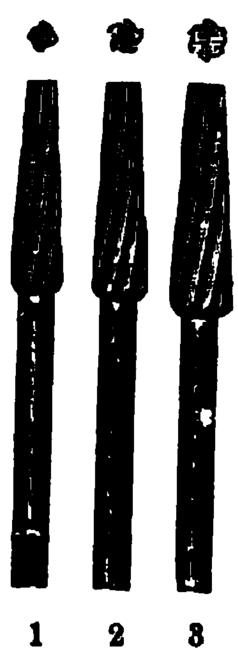
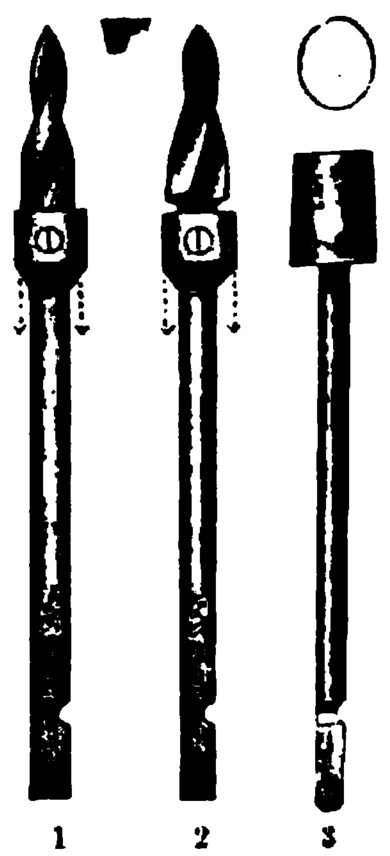


Fig. 542.

SPIRAL KNIVES. TUBULAR KNIVES.



greatest dangers is the inoculation of disease; and this objection can also be urged against transplantation with equal force.

Figs. 540, 541, and 542 represent implantation instruments for Dr. Younger's operation.

The hole in the jaw bored to that depth by the trephine is then enlarged by the reamers to fit the root which is to be implanted.

Tubular Knife No. 3 is a medium size, with which the soft tissues are cut to the bone. For the incisors and cuspids, the hole this makes corresponds fairly with the shape of the tooth at the neck. For the bicuspids, which have a more or less oblong shape on cross-section, this round hole would, apparently, not be of the correct shape. It is only necessary, however, to have a tubular knife which

measures a little less in circumference than the tooth at its neck to insure a perfect fit, for the soft tissues are elastic enough to conform to the tooth if the hole is large enough.

Spiral Knife No. 1 has two blades. In use it is pressed against the bone and pushed in to the shoulder, which should be adjusted to the proper position. This instrument cuts the bone with great rapidity and without any special pain.

No. 2 is a similar knife, only more conical. This is pressed into the hole previously made, and then swayed to enlarge the cavity to fit the root. It will be necessary to use this but twice, as the eye carries the shape of the root with enough accuracy to enable one to get the hole of almost the right shape the first time.

CHAPTER VIII.

DISLOCATION AND FRACTURE OF THE JAW.

FROM the peculiar manner in which the inferior maxilla is articulated to the temporal bones, it is not very liable to dislocation. When it occurs in one or both of the condyles, the luxation is always forward, the conformation of the parts preventing it from taking place in any other direction. The oblong, rounded head of each condyle is received into the fore part of a deep fossa in the temporal bone, situated just before the meatus auditorius externus, and under the beginning of the zygomatic arch. The articular surface of each is covered with a smooth cartilage, and between them there is a movable cartilage. This latter is connected with the articulating surfaces of the condyle and glenoid cavity, externally by the external lateral ligament, internally by the capsular ligament, and in front by the tendon of the external pterygoid. This cartilage is sometimes called the meniscus, from its shape, being thickest around its circumference, especially at the back part. The temporo-maxillary articulation is strengthened by an internal, an external, and a capsular ligament, also by the tendinous and muscular insertions of the masseter, temporal, and pterygoid muscles. The intervening movable cartilage, being more closely connected with the head of the condyle than with the glenoid cavity, escapes with the former whenever dislocation of the jaw takes place.

Dislocation of the lower jaw is rarely caused by a blow, unless given when the mouth is open; it is more frequently occasioned by yawning or laughing. It has been known to occur in the extraction

of teeth, and in attempting to bite a very large substance. Sir Astley Cooper mentions the case of a boy who had his jaw dislocated by suddenly putting an apple into his mouth to keep it from a playfellow.

After the jaw has been dislocated once, it is always more liable to this accident; consequently, Mr. Fox very properly recommends to those with whom it has once happened the precaution of supporting the jaw whenever the mouth is opened very widely in gaping or for the purpose of having a tooth extracted. None of these causes would be sufficient to produce the accident, unless the ligaments of the temporo-maxillary articulation are very loose and the muscles of the jaw much relaxed.

The author witnessed a case of dislocation of the lower jaw in which the displacement occurred during an attempt to extract the first right inferior molar. The patient was a young lady from Virginia, about seventeen years of age. Both condyles were luxated, but so completely were the muscles of the jaw relaxed that he immediately reduced it without the least difficulty, and afterward, by supporting the jaw with his left hand, succeeded in removing the tooth.

When the lower jaw is dislocated, the mouth remains wide open, as seen in Fig. 543, and a great deal of pain is experienced; this, according to Boyer, is caused by the

FIG. 543.

pressure of the condyles on the deep-seated temporal nerves and those which go to the masseter muscles, situated at the root of the zygomatic process. The condyles, having left their place of articulation, are advanced before the articular eminences and lodged under the zygomatic arches. The jaw cannot be closed; the coronoid processes may be felt under the malar bones; the temporal, masseter, and buccinator muscles are extended; the articular cavities being empty, a hollow may be felt there; the saliva flows uninterruptedly from the mouth, and deglutition and speech are either wholly prevented or very greatly impaired. Boyer says that during the first five days after the accident the patient can neither speak nor swallow. The jaw, when only one condyle is displaced, is forced more or less to one side.

If the dislocation continues for several days or weeks, the chin

gradually approaches the upper jaw, and the patient slowly recovers the functions of speech and deglutition. We are told by Mr. Samuel Cooper that it may prove fatal if it remains unreduced;* but Sir Astley Cooper says he has never known any dangerous effects to result from this accident; on the contrary, after it has continued for a considerable length of time the jaw partially recovers its motion.†

In the reduction of dislocation of the lower jaw the older surgeons employed two pieces of wood, which were introduced on each side of the mouth, between the molar teeth; while these were made to act as levers for depressing the back part of the bone, the chin was raised by means of a bandage.

The method usually adopted by modern surgeons for reducing a dislocation of this bone consists in introducing the thumbs, wrapped in a napkin or cloth (to prevent them from being hurt by the teeth), as far back upon the molars as possible; then depressing the back part of the jaw and at the same time raising the chin with the fingers. In this way the condyles are disengaged from under the zygomatic arches and made to glide back into their articular cavities. But the moment the condyles are disengaged the thumbs of the operator should be slipped outward between the teeth and the cheeks, as the action of the muscles at this instant, in drawing the jaw back, causes it to close very suddenly and with considerable force. This precaution is necessary to avoid being hurt, unless a piece of cork or soft wood has been previously placed between the teeth.

By the foregoing simple method the dislocation may, in almost every case, be readily reduced; but Mr. Fox mentions a case in which it failed. The subject was a lady whose lower jaw had been luxated several times before; this time the accident was occasioned by an attempt which he made to extract one of the inferior dentes sapientiæ. After having failed to reduce the luxated bone by the usual method, he "happened to recollect a statement made to him by M. de Chemant, who, having been frequently applied to by a person in Paris who was subject to this accident, had always succeeded in immediately reducing the luxation by means of a lever of wood, as recommended by Dr. Monroe." Profiting by this statement, Mr. Fox procured a piece of wood about an inch square and ten or twelve inches long. He placed one end of this upon the lower molars, and then raised the other, so that the upper teeth acted as a fulcrum. As soon as the jaw was depressed the condyle

* Surgical Dictionary, p. 306. † A. Cooper on Dislocations, p. 389.

of the side upon which the wood was applied immediately slipped back into its articular cavity. The wood was then applied to the opposite side of the jaw, and the other condyle reduced in the same manner.*

The method practiced by Sir Astley Cooper consists, when both condyles are displaced, in introducing two corks behind the molars and then elevating the chin. He, however, first places his patient in a recumbent posture; † but this is seldom necessary. The reduction of the dislocation can be as conveniently effected with the patient in a sitting as in a recumbent posture.

After the reduction of the dislocation the patient is recommended to abstain for several days from the use of solid aliments and to wear a four-tailed bandage; ‡ or, what is still better, the bandage contrived by Mr. Fox (Fig. 258, p. 444), to prevent its recurrence in the extraction of teeth. When this bandage is used for the latter purpose the mouth is first opened to the proper extent, with the condyles in their articular cavities; it is then applied, and the straps tightly buckled. This done, it is impossible to advance the jaw sufficiently to produce a dislocation.

FRACTURES OF THE JAWS.

Fractures of the jaws rarely occur except from direct violence. In the upper jaw this violence is usually of a character that complicates the fracture with severe injury to adjacent parts. Gunshot wounds are by far the most frequent source of fractures in this locality; and it is wonderful what an amount of injury to the bones of the face may be recovered from without ill result. The bones of the face are of softer character than those found elsewhere, and consequently the whole injury is at the place of impact and along the course of the ball; no long fractures or extensive contusions are found, or very rarely so, and the parts are abundantly supplied with blood, hence the restorative process proceeds very rapidly; but this abundant sanguineous supply, so useful in the restoration of parts, is also the chief source of danger. Hemorrhage is generally excessive and difficult to control, and to secondary hemorrhage is due the greatest fatality in injuries of this kind, ligature of the carotid artery, which has been frequently practiced, usually serving but to postpone the fatal termination. Owing to the liberal supply of blood, necrosis seldom occurs, and it is seldom necessary to remove fragments of bone, even after the most extensive comminu-

* American edition of Fox on the Human Teeth, p. 330.

† A. Cooper on Dislocations, p. 391.

‡ Cooper's Surgical Dictionary, p. 306.

tion; they should be left, except for some peculiar reason, until death is manifest in them, when they may be abstracted without additional trouble. Loosened teeth should always be left to contract adhesions, which they will generally readily do. Indeed, but little surgical interference is required in cases of this kind, and should usually be limited to efforts to secure the proper apposition of the teeth. Numerous cases of the most extraordinary injuries to the face are to be found in the surgical reports of the late war in the States, and in those of the French and English surgeons during the wars of the first Napoleon and the Crimea. Fractures of the superior maxilla may, however, occur from other violence than gunshot wounds. Mr. Salter reports a case resulting from the collision of the face and head of two "cricketers." The kick of a horse, as in the well-known Wiseman case, has occasioned frightful injury of this character. In this case the "face was driven in, the lower jaw projecting forward. . . . The bones of the palate were driven so far back it was impossible to pass my finger behind them." The patient made a good recovery. Mr. Heath records a case reported by Dr. Tyffe, in which, "on watching the patient's profile while in the act of swallowing food, the whole of the bones of the face were observed to move up and down upon the fixed part of the skull as the different parts were brought into motion. It appeared as if the integuments only retained them in their position. It was a curious feature in the case that, notwithstanding the very extensive injury done and the violent character of the force which caused it (the upsetting of a cab), not a single tooth was fractured or misplaced." Fractures in the dentist's chair, from ill-directed efforts to remove teeth, not uncommon when "keys" were in general use, are now so infrequent as to be undeserving of special mention.

Among the complications of fracture of the upper jaw may be mentioned breaking and displacement of teeth, closure of the nasal duct with consequent epiphora, secondary hemorrhage, and paralysis of the infra-orbital nerve as the most common.

Diagnosis of fractures of the upper jaw is usually attended with but little difficulty. It is determined by pain, crepitation, irregularity in the line of the teeth, and excessive secretion of saliva. The treatment consists in the nice adaptation of the teeth and their permanent security in proper position. This is generally effected with but little difficulty, by a single finger passed into the mouth to press the fragments into position, where they may be secured by wires, or, in cases of great displacement, by the interdental splint. The hemorrhage should be controlled by styptics, of which the persul-

phate of iron is the best, by the actual cautery, and, when not otherwise manageable, by ligation of the carotid artery.

Fractures of the lower jaw are much more common than those of the upper. They give comparatively little trouble, are readily diagnosed, and are occasioned by direct violence, as in the upper jaw. The most common seat of fracture is the middle of the horizontal ramus. Before the use of interdental splints, fractures of the lower jaw were difficult of adjustment and were frequently attended with bad results, and in rare cases they still are so. A good many forms of apparatus have been devised, of which the simplest is the four-tailed bandage, which consists of a slip of muslin, of suitable dimensions, torn from each extremity toward the centre, leaving enough space to receive the chin. It is secured by passing the tails over the top of the head and around the back of the neck, and tying them in this position. This apparatus may be supplemented by a pasteboard splint moulded to the form of the jaw. Sometimes the bones are secured in position by passing wires around the firm teeth and binding them together. They may also be secured by sutures, the bones having been drilled to permit their passage. Mr. Wheelhouse, of Leeds, recommends that, after drilling through the bones on either side of the fracture, silver pins "with flat, circular, and perforated heads" be passed through the opening from within outward, and their points bent in opposite directions so as to form hooks, and the fragments secured by passing silver or gold wire in a figure-of-eight over the pins. The perforations in the head of the wires are for silk sutures, by which they may be readily removed when necessary. It is also recommended that not only should the fragments be secured together in this way, but that they also be bound to the upper jaw. Wedges of cork cut into suitable shapes; of gutta-percha, introduced and moulded to the teeth; Mutter's silver clamps, or their modification by Mr. Tomes; Hayward's silver caps, and other more complicated apparatuses may, in our judgment, be all superseded by the vulcanite interdental splint contrived about the same time and independently of each other by the late Dr. Bean, of Baltimore, Md., and Dr. Gunning, of New York, except in cases of obstinate vertical displacement. An impression in wax is first taken of both jaws, from which a plaster cast is taken, and upon this the vulcanite plate is accurately moulded with indentations corresponding exactly to the adjusted teeth, and with an interspace at the most convenient point for administering food. The splints are now introduced into the mouth, the teeth arranged in their appropriate indentations, and the whole fixed in position by a mental compress and occipito-frontal bandage, thus securing the

jaws from motion and the splint from displacement. The compress consists of a light piece of wood, on which is fixed a metallic cup of form and size adapted to the patient's chin, to each extremity of which is affixed a metallic side-piece four or five inches in length and from three-quarters to one inch in width. Encasing these side-pieces are the temporal straps, made of stout cloth and secured by a strong cord at the base of each piece. The occipito-frontal bandage is composed of a band passing around the head from the forehead to the occipital protuberance behind, and secured by a buckle one inch to the right of the median line behind; of another strap secured to the

FIG. 544.

band in front and behind; and a third strap extending from the temporal buckles on either side and secured to the middle strap at the point of crossing. (See Fig. 544.)

An "impromptu interdental splint," the suggestion of Professor Gorgas, and which he has employed with great satisfaction in hospital practice, both in the case of single and double fractures of the maxillæ, is described as follows:—

Taking the case of fracture of the inferior maxillary for example, after all the parts are brought in apposition and secured by wire or silk ligatures, a partial lower mouth cup or tray, of the proper size to suit the arch, is selected. This mouth cup is of the form having an opening or cavity to allow the front teeth under other circumstances to pass through, or, what is better, is cut out in the form represented by Fig. 545 for the lower jaw and Fig. 546 for the upper jaw.

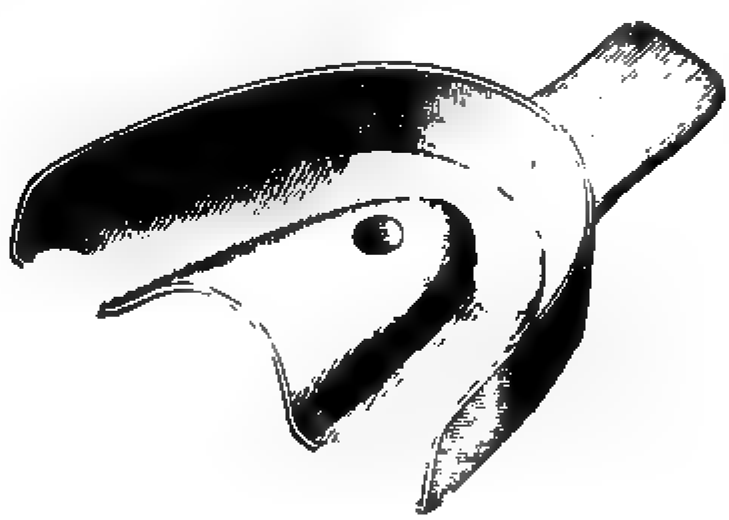
The partial lower cups with flat bottoms and square sides are more suitable than the round-bottom cups, but the latter may be used with advantage where the jaw is edentulous.

When the fractured portions are secured in position by ligatures, the cup is filled with softened modeling composition and introduced

FIG. 545.

into the mouth in the same manner as when taking an impression for a partial lower set of teeth and pressed carefully into place. The opening or cavity in the front part of the cup will allow the modeling composition to press through to the upper surface, and into this excess the patient is directed to bite with the superior front teeth,

FIG. 546.



and the modeling composition is adapted, by pressing on it with the finger, to the labial surfaces of these teeth. This completes the formation of the interdental splint, which the patient is to wear until union of the fractured parts takes place. The handle of the cup, which is necessary for its introduction into the mouth, is then cut off close to the cup with a fine saw, in order that it may not inconvenience the patient by projecting beyond the lips. The openings

on each side over the bicuspid and molar teeth will permit the introduction of nourishment, without disturbing the appliance. A bandage is then passed over the top of the head and under the chin, and thus an easy and rapidly formed "interdental splint" is improvised, which has given satisfaction in every case where it has been applied, and permitted of removal in from three to four weeks from the time it was applied. Special splints with an adjustable handle, which may be removed by unscrewing it, have been devised by Professor Gorgas, for the treatment of fracture of both jaws, which are better adapted to the parts than the ordinary mouth cups employed for obtaining impressions in the construction of sets of artificial teeth.

CHAPTER IX.

DISEASES OF THE ANTRUM.

THE cavity known as the antrum of Highmore, or maxillary sinus, is situated in the body of the superior maxillary bones, on either side of the nose and beneath the orbit of the eye. It is an irregular cavity, varying in size in nearly every superior maxillary bone, and often divided into several parts by vertical partitions (septi) of bone, an observation of many bones being necessary to show its extent and general form. The alveolar process immediately over the ends of the roots of the first and second superior molars and bicuspids forms the floor of the antrum; hence it is readily seen how abscesses of the roots of these teeth may involve this cavity.

One of the nasal openings of the antrum, of which there are two in the middle meatus of the nose, when in a normal condition, is very nearly closed by a duplicature of the membrane lining the turbinated and other adjoining bones, and secretions may readily accumulate when this outlet into the nose is closed by congestion of the membrane, giving rise to serious symptoms, such as disfigurement, pain, etc. The other opening is very small, and can only be entered with the point of a probe. The mucous membrane which lines the nares passes through these openings into the antrum, and lines this cavity also.

The antrum is subject to some of the most formidable and dangerous diseases the medical or surgical practitioner is ever called upon to treat; and yet there are few diseases incident to the human body that have received less attention from writers on pathology and therapeutics than these. There are diseases here met with over

which neither the surgeon nor physician can exercise any control, the progress of which ceases only with the life of the unfortunate sufferer.

All of the diseases to which the maxillary antrum is subject, however, are not of so dangerous a character, for some are very simple and easily cured; but even those which are regarded as the least dangerous, and which yield most readily to treatment when instituted during their incipient or earlier stages, may assume, if neglected or improperly treated, a form so aggravated as to bid defiance to the skill both of the physician and surgeon. While thus, on the one hand, the most simple affections of this cavity may, by neglect or improper treatment, become ultimately incurable, many of those, on the other hand, which are considered the most malignant and dangerous, might, we have no doubt, by timely and judicious treatment, be effectually and radically removed.

The form which the disease puts on is determined by the state of the constitutional health or some specific tendency of the general system; and we can readily imagine that a cause which, in one person, would give rise to simple inflammation of the lining membrane, or mucous engorgement of the sinus, would in another produce an ill-conditioned ulcer, fungus hæmatodes, or osteo-sarcoma. Simple inflammation and mucous engorgement not unfrequently causes caries and exfoliation of the surrounding osseous tissues, and, in some instances, even the destruction of the life of the patient.

The importance of early attention to the diseases of this cavity is, therefore, very apparent; and this is the more necessary as it is often difficult and sometimes impossible to determine the character of the malady until it has progressed so far as to involve, to a greater or less extent, the neighboring parts, when, if it has not become incurable, its removal is, to say the least, rendered less easy of accomplishment. It may be safely assumed, therefore, that in a very large majority of the cases of diseases of the maxillary sinus, the danger to be apprehended arises more from neglect than from any necessarily fatal character of the malady, so that in forming a prognosis, the circumstances to be considered are the state of the constitutional health, the progress made by the affection, and the nature of the injury inflicted by it upon the surrounding tissues. If the general health is not so much impaired as to prevent its restoration by the employment of proper remedies, and the neighboring structures have not become implicated, the prognosis will be favorable; but if the functional operations of the body have become very much deranged, and the bones of the face and nose seriously affected, the combined resources both of medicine and surgery will prove unavailing.

In young and middle-aged subjects of good constitution, a morbid action may exist in the antrum for years without giving rise to any alarming symptoms, while the same affection in another less healthy might rapidly extend and degenerate into a form of disease so malignant as to threaten the speedy destruction of the life of the patient. Medical history abounds with examples of this kind, and conclusively establishes the fact that the state of the general health and habit of body, whatever may have been the primitive characteristics of the malady, ultimately determines its malignancy; in the treatment of affections of this cavity, therefore, as well as of other local diseases of the body, the condition of the system should not be overlooked.

Independently of the danger arising from the local affection, diseases of the antrum are, for the most part, very loathsome, and subject the patient to great annoyance. They change the quality of its secretions, and cause them to exhale a fetid, nauseating odor. This, in many instances, is almost insufferable to the patient, and when they are prevented from escaping through the natural opening into the nose, they pass through one artificially formed by the surgeon, or made by the disease through the cheek, alveolar border or palatine arch, always causing the patient great inconvenience.

The progress of disease in this cavity is often very insidious. It not unfrequently happens that it exists for weeks and even months before its existence is suspected. The slight uneasiness felt is attributed to some morbid condition of the teeth or gums, and the symptoms attendant upon one description of affection are often so similar to those that accompany another, that it is impossible to determine its true character until it has made considerable progress.

The morbid affections of the maxillary sinus are, for the most part, similar to those of the nasal fossæ. There is, however, one form of disease which seems to be peculiar to this cavity, viz., mucous engorgement. Deschamps mentions two kinds of accumulations, dropsical and purulent; but the first of these is, properly speaking, a disease of serous membranes, and is never met with in this cavity; and authors who have enumerated it among its diseases, have evidently mistaken mucous engorgement for it. The fluids that accumulate here are of a mucous or muco-purulent character, except when they are the result of the disorganization of some of the surrounding parts; then they are sanious.

The most simple form of disease that occurs here is inflammation of the lining membrane, and this, in most instances, may be said to precede all others. It often subsides spontaneously; but when it continues for a long time it is apt to become chronic, and may then

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give rise to other and more formidable kinds of disease. When unattended by any other morbid affection, either local or constitutional, it is easily cured.

A purulent condition of the fluids of the antrum is a common affection, but is seldom met with in persons of good constitution. It seems to be dependent upon a bad habit of the body; also upon inflammation of the mucous membrane of the sinus, which arises more frequently from dental irritation than any other cause. This condition of the secretions sometimes gives rise to caries and exfoliation of portions of the surrounding bone and to fistulous ulcers; but when dependent upon no other local cause than simple inflammation of mucous membrane, it is seldom that such effects result from it. When complicated with other morbid conditions of the cavity they are not infrequent.

All purulent secretions of this membrane are by some denominated abscess. The name, however, as is justly remarked by Mr. Thomas Bell, is improper. The term abscess is more correctly applied to purulent collections in the areolar tissue—either submucous, subserous, subcutaneous, intermuscular, or parenchymatous. It seldom originates in the submucous tissue of the antrum, but proceeds occasionally from disease in the cancellated structure of the surrounding bones. Instances of it have been met with at the extremities of the roots of teeth which had perforated the sinus, and it sometimes happens that when an abscess is seated in the alveolus of a superior molar, the matter, instead of making for itself a passage through the socket of the tooth on either side, escapes into this cavity, and thence with the antral secretions through the nasal opening. Mr. Bell describes a case of abscess seated in the upper part of the antrum; but this and one other are the only examples of this kind on record.

Ulceration of the lining membrane is an affection less frequently met with. It is rarely, if ever, idiopathic, but seems rather to be dependent upon some other local malady or some specific constitutional vice. Scorbutic and scrofulous diatheses, and those affected with a venereal taint, are more liable to ulceration of this membrane than persons of sound constitution. Consequently, it is seldom cured by local remedies alone. It is almost always complicated with fungus of the membrane and caries of the walls of the sinus, and may, if neglected, take on a cancerous form and become incurable.

The next form of disease is caries of the antral parietes. This, though always complicated with other forms of diseased action, seems, nevertheless, to be worthy of separate consideration. Like

ulceration of the lining membrane, it is the result of some other affection. It may result from accumulation of the secretions of the sinus, from ulceration, or from tumors.

The occurrence of fungus or polypus and of various kinds of tumor is less frequent than any of the preceding affections; yet this cavity is not exempt from them, and they constitute the most dangerous form of disease to which the superior maxilla is subject. Although it is probable that in their incipient stage they might in nearly every instance be radically removed, it is seldom they are cured after they have attained a very large size, and have implicated to considerable extent the surrounding tissues. They have, however, been successfully extirpated even after they had acquired great volume, and implicated to such an extent the surrounding parts as to render necessary the removal of the whole of the superior maxillary bone. They usually grow with great rapidity, and if not completely removed are soon reproduced.

Besides these, other varieties of disease are occasionally met with here. The antrum is liable to injuries from blows and other kinds of mechanical violence, and from the introduction of insects and foreign bodies. The diseases of the maxillary sinus are supposed to be dependent upon certain specific constitutional vices; upon the obliteration of the opening of this cavity into the nose, and upon dental irritation. That all of these may at times be concerned in their production is more than probable. But actual disease rarely develops itself spontaneously as a consequence merely of a bad habit of body or constitutional vice. This does not of itself originate disease, but only occasions an increase of susceptibility of the tissues to morbid impressions; so that when an unhealthy action is once induced here, a more aggravated or a different form of disease occurs than that which would otherwise have been produced.

Thus it may be seen that disease of the maxillary sinus is dependent upon some exciting cause, favored by some constitutional vice; for without this no serious morbid effects would be produced, or if produced, they would be of a different or less aggravated character. Any disposition or vice of body which weakens the vital energies of the system increases the susceptibility, or rather *excitability*, of all its parts—those of this cavity equally with the rest. There are various kinds which have this effect; as, for example, the scorbutic, scrofulous, venereal, mercurial, etc., each of which may influence the character of the morbid action in a manner peculiar to itself; or it may be similar to that which might be exercised by another, only causing it to assume a greater or less degree of malignancy,

accordingly as the functional operations of the body generally are more or less enervated by it.

This seems to be the way in which a bad habit of body is capable of affecting the maxillary sinus. It is a predisposing, but not an exciting cause of disease; and it is important that this distinction should be borne in mind. The one should never be confounded with the other, because an error of this sort might, in many instances, lead to the adoption of incorrect views concerning the therapeutical indications of the disease. This part of the subject we shall have occasion to advert to hereafter.

Inflammation and ulceration of the nasal pituitary membrane sometimes extend themselves to the maxillary sinus; but disease is not so frequently propagated from the nasal fossæ to this cavity as the intimate relationship between the two might lead one to suppose. It is seldom that both are affected at the same time. Hence, we infer that although lined by one common membrane, the propagation of disease from one to the other is a rare occurrence.

The obliteration of the nasal opening of this cavity is sometimes caused by disease in the nose, and is followed by mucous engorgement of the sinus, inflammation of the lining membrane, distention of the osseous walls, and not unfrequently by other and more complicated forms of disease. But the closing of this opening is oftener an effect than a cause of disease in this cavity, and it generally reëstablishes itself without any assistance of art after the cure of the affection which caused it.

If all the circumstances connected with the history of the diseases under consideration could be ascertained, we think it would be found that these affections are more frequently induced by a morbid condition of the teeth, gums, and alveolar processes than any other cause. There are, in fact, no sources of irritation to which this cavity is so much and so often exposed as those arising from dental organism. It is separated from the apices of the roots of the superior molars and bicuspids by only a very thin plate of bone, and is sometimes even penetrated by them; so that it could scarcely be otherwise than that aggravated and protracted disease in the teeth and alveoli should exert an unhealthy influence upon it. The pain occasioned by diseased teeth is often very severe, sometimes almost excruciating, and inflammation in the alveolo-dental periosteum and gums frequently extends itself to the whole of one side of the face. It would hardly be possible, therefore, for this cavity to escape. Alveolar abscess and sometimes necrosis and exfoliation of the socket of the affected tooth arise from the inflammation thus lighted up. It often happens that the gums and

alveolar periosteum are affected for years with chronic inflammation and other morbid conditions.

If, in addition to these facts, other proofs be necessary to establish the agency of dental and alveolar irritation in the production of disease in the maxillary sinus, they may be found. Many of the affections here met with are often cured by the removal of diseased teeth after other remedies have been employed in vain, and that without even perforating the antrum. This would not be the case if the irritation did not arise as a consequence of the dental malady.

Most writers on diseases of the sinus agree in ascribing them to a morbid condition of the teeth and alveoli. There are some, however, who, though they admit that dental irritation may perhaps occasionally give rise to them, seem, nevertheless, to attribute their occurrence in the majority of instances to other causes, such as irregular exposure to cold, blows upon the face, and certain constitutional diseases. We shall now proceed to the consideration of some of the more common affections of this cavity, under their respective and appropriate heads.

Inflammation of the Lining Membrane of the Maxillary Sinus.—Inflammation, when not complicated with any other morbid affection, is the most simple form of disease to which the pituitary membrane of the antrum is subject. As it precedes and accompanies all others, it will be proper to offer a few remarks upon it before entering upon the consideration of those of a more aggravated nature.

Inaccessible as it is here to most of the acrid and irritating agents to which it is exposed in the nasal fossæ and some other cavities of the body, it would rarely become the seat of inflammation were it not for its proximity to the teeth and alveolar border; and simple inflammation rarely gives rise to any other form of diseased action, unless favored by some general morbid tendency, but usually subsides spontaneously on the removal of the exciting cause. In good constitutions it is less subject to inflammation, and consequently to any other description of morbid action, than those in whom there exists some vice of body or constitutional predisposition. Febrile and gastric affections, eruptive diseases, such as measles, smallpox, etc., syphilis, and excessive and protracted use of mercurial medicines, a scorbutic or scrofulous diathesis of the general system—in short, everything that has a tendency to enervate the vital powers of the body, increases its irritability.

When in a healthy condition it secretes a slightly viscid, transparent, and inodorous fluid, by which it is constantly lubricated; but inflammation changes the character of the secretion. It causes it to become vitiated; at first less abundant, it is afterward secreted in

larger quantities than usual, becomes more serous, and so acrid as sometimes to irritate the membrane of the nose, over which it passes after having escaped from the antrum. It also exhales an odor more or less offensive, accordingly as the inflammation is mild or severe. It moreover gives rise to a thickening of the membrane, and sometimes to obliteration of the nasal opening. This last rarely occurs, but when it does happen an accumulation of the secretion and other morbid phenomena, of which we shall hereafter treat, result as a necessary consequence.

If at any time during the continuance of the inflammation the patient is attacked with severe constitutional disease, the local affection will be aggravated and sometimes assume a different character.

The inflammation, when long continued, degenerates into a chronic form, and is sometimes kept up for several years without giving rise to any other unpleasant symptoms than occasional paroxysms of dull and seemingly deep-seated pain in the face and a vitiated condition of the fluids of this cavity. The slightly fetid odor which they exhale ceases to be annoying or even perceptible to the patient when he becomes accustomed to it.

Symptoms.—The symptoms of inflammation here, though not always precisely the same as elsewhere, are, for the most part, very similar. They are severe, fixed, and deep-seated pain under the cheek, extending from the alveolar border to the lower part of the orbit; local heat, pulsation, and sometimes fever. Boyer says these symptoms are not always present, and that inflammation may exist when it is not expected. Other affections of the face and superior maxilla may be mistaken for this, and this for others; but that inflammation should exist without being attended with pain or any other signs indicative of its presence, is scarcely probable.

Deschamps distinguishes the symptoms of this from those of other affections of this cavity by a dull, heavy pain in the region of the sinus, which, he says, becomes sharp and lancinating and extends from the alveolar arch to the frontal sinus. The disease goes on without interruption, increasing until the superior maxilla of the affected side is more or less involved. This malady, he says, cannot be confounded with any other, even where there is no external visible cause; differing from a simple retention of mucus by being painful at the commencement, and by not being accompanied with swelling of the bones; from polypus, by the continuance of pain; and from cancer, by the character of the pain. "Suppuration and ulcers have peculiar signs which cannot be confounded with those of inflammation." Pain in the molar and bicuspid teeth, accompa-

nied by a sense of fluctuation in the parts, he seems to regard as a very certain indication of inflammation, and especially when joined to the other symptoms. "If an external cause is discovered, it will furnish a certain diagnosis;" he also mentions fever and headache as almost invariable accompaniments.

The inflammation, if not subdued by appropriate remedies, after having continued for a length of time, gradually assumes a chronic form; the pain then begins to diminish and is less constant; it becomes duller and is principally confined to the region of the antrum. The teeth of the affected side cease to ache, or ache only at times, but still remain sensitive to the touch. The mucous membrane of the nostril next the diseased sinus is often tender and slightly inflamed; and if in the morning, or after two or three hours' sleep, the other nostril be closed by pressing upon it with the thumb or one of the fingers, and a violent expiration be made, a thin, watery fluid of a slightly fetid odor will be discharged, and pain will be experienced in the region of this cavity.

Causes.—All morbid conditions of the teeth and gums, causing irritation in the alveolar periosteal tissue, may be regarded as among the most frequent of its exciting causes, especially caries, necrosis, and exostosis; also, loose teeth and the roots of such as have been either fractured in an attempt at extraction or by a blow or fall, and left in their sockets, or that have remained after the destruction of their crowns by decay. It sometimes happens, too, that inflammation is excited in this membrane by fractured alveoli; but when an accident of this sort occurs the detached portions of bone are generally soon thrown off by the economy, and, the cause being removed, the inflammation immediately subsides. Not so with the roots of the teeth. They often remain concealed in their sockets for years, unless removed by art. Nature, it is true, makes an effort to expel them from the jaw, but this is accomplished only by a slow and very tedious process, and not, in many instances, until they have given rise to some serious affection. But of the deleterious effects that result from necrosed roots of teeth in the alveoli it is not necessary now to speak; as extraneous bodies, they are always productive of more or less irritation. We might also mention exposure to sudden transitions of temperature and certain constitutional diseases as among the causes which occasionally give rise to inflammation of this membrane.

Treatment.—The curative indications of inflammation of the lining membrane of the antrum are simple and, for the most part, similar to those of inflammation in other parts of the body. In many cases great benefit will be derived from the application of leeches to the

cheek, as recommended by Mr. Thomas Bell. When the disease is dependent, as in most cases it is, upon an unhealthy condition of the alveolar processes, the first thing to be done is to remove all such teeth or roots of teeth as are productive of the least irritation: for, while any local sources of irritation are permitted to remain, neither topical nor general bleeding, or, indeed, any other treatment, will be of permanent advantage.

Simple inflammation of the lining membrane of the antrum would be of little consequence were it not that it is liable to give rise to other and more dangerous forms of disease, such, for instance, as engorgement or a purulent condition of its secretions. It should never, therefore, be permitted to continue, but be as speedily arrested as possible; and for the accomplishment of this the means here pointed out will, if timely and properly applied, be found fully adequate.

Purulent Condition of the Secretions and Engorgement of the Antrum.—A purulent condition of the secretions of the antrum and mucous engorgement are indiscriminately, though very improperly, denominated by many writers on the affections of this cavity, abscess. To this neither bears the slightest resemblance. Deschamps treats of the former under the name of suppuration, and the latter dropsy. Of the first he says: "If, by the time the inflammation has passed, the surrounding parts cease to be painful, while the affection still continues to cause pain in the antrum, and the fever, though diminished, occurs at irregular intervals, and if the inflammation is followed by pulsating pain, we have reason to suppose that an abscess has formed in the sinus; and all doubt will be removed if, on the patient's inclining his head to the opposite side, matter is discharged into the nostrils, or if some tubercles are formed near the outer angle of the eye, or alveolar border, which last happens more frequently; and finally, if the purulent matter, not finding any opening through which to discharge itself, distends the sinus to such an extent as to form a tumor outwardly upon the cheek." In short, all the symptoms which he mentions as belonging to the disease are those accompanying the one under consideration. The matter, he says, is of a "putrid, serous consistence."

Bordenave has fallen into a similar error. He terms an altered state of these secretions suppuration of the membrane, and says that inflammation is not necessary to it. He seems to have confounded with abscess of the antrum those cases of alveolar abscess where the matter, instead of discharging itself, as it ordinarily does, by an opening through the alveolus and gum into the mouth, passes into the cavity. Again he asserts that the disease (suppuration, as

he calls it) may be independent of the surrounding parts; and although ordinarily implicated with an altered condition of them, he affirms, it is sometimes the effect of disease primarily seated in the cavity.

There is no doubt that a purulent condition of the fluids of this cavity is often complicated with ulceration of the lining membrane; but that the affection is different from abscess, its very nature and situation are sufficient to show. "A reference to the structure of the antrum," says Mr. Bell, "would appear to be sufficient to point out the improbability, to say the least, of the occurrence of abscess in such a situation. That a mucous membrane covering, in a thin layer, the whole internal surface of such a cavity, should become the seat of all the consecutive steps of true abscess, is a statement bearing on the face of it an obvious absurdity." Notwithstanding the seeming improbability of such an occurrence—and it is certainly one that very rarely happens—abscess does sometimes develop itself in this cavity; but it is a different affection altogether from that usually treated of under that name.

When complicated with ulceration of the mucous membrane—and it is probable that a purulent condition of its secretions, in most instances, is thus complicated—the affection is analogous to ozæna, and many of the older writers designate it by that name. Mr. Bell describes it, and very properly too, as being similar to gonorrhœa; both diseases alike consist in an alteration of secretion; in the one case of the pituitary membrane, and in the other of the mucous lining of the urethra; but in neither instance does it possess any of the characteristics of abscess, though the matter in both is purulent.

It has been before stated that the obliteration of the nasal opening was more frequently an effect than a cause of disease in the maxillary sinus; it does, however, sometimes become closed from other causes than an unhealthy condition of this cavity; when this happens, engorgement of the sinus is the inevitable consequence. The fluids thus accumulated are not always at first purulent, although they may subsequently become so; when the closing of the opening is the result of previous disease in the antrum, the secretions are more or less altered from the very first.

Accumulation of any secretion within the antrum, whether of mucus or pus, is a source of irritation to the lining membrane, and the pressure which it ultimately exerts upon the surrounding walls causes a new form of diseased action, which not unfrequently involves in disease all the bones of the face as well as those of the base of the cranium. When prevented from escaping through the

nasal opening, the secretion eventually makes for itself a way of escape—sometimes through the cheek; at other times beneath it, just above the alveolar ridge; or through the palatine arch or alveoli by the sides of the roots of one or more of the teeth; and from a fistula thus established, fetid matter will be almost constantly discharged. From openings of this sort the matter is sometimes discharged for years, while the disease in the antrum, very frequently, does not seem to undergo any apparent change. At other times the membrane ulcerates and the bony walls become carious.

A purulent secretion from the mucous membrane of this cavity, independently of caries of the bone, or even of simple fistulous openings, is an exceedingly troublesome and unpleasant affection. The odor from the matter is often very annoying, even to the patient, and when the secretions are retained for some days in the sinus before they escape, the fetor is almost insufferable.

In good constitutions the secretions of the antrum are not so liable to become purulent, though they be confined for a long time in the cavity, and thus become more or less offensive. Inflammation of the lining membrane (the immediate or proximate cause) may exist for years without giving rise to it. It is only in scrofulous, scorbutic or debilitated habits that they are liable to become thus altered. The difference in the effects produced upon them and the surrounding parts by inflammation, is owing to the difference in the state of the constitutional health of those affected with it.

Where a puriform state of the secretions is complicated with ulceration of the membrane, the matter will have mixed with it a greater or less quantity of flocculi, sometimes of so firm a consistence as to block up the nasal opening and prevent its exit. Mr. Thomas Bell says he has seen more than one case in which a considerable accumulation had taken place in the antrum, accompanied by the usual indication of this affection (muco-purulent engorgement of the sinus), when a sudden discharge of the contents into the nose took place, "in consequence of the pressure having overcome the resistance which had thus been offered to its escape." Cases of a very similar nature have fallen under our observation, the history of one of which will be given in the course of this chapter. The formation of these flocculi rarely ceases, except with the cure of the ulcers on the membrane. They give rise to considerable irritation, and their presence always constitutes an obstacle to the cure. They are usually removed by injections.

The pituitary membrane of the antrum, when in a healthy state, secretes, as we have before stated, a transparent, slightly viscid and

inodorous fluid, poured out only in sufficient quantity to lubricate the cavity. But when inflammation is excited in the membrane, its secretions soon become more abundant, and are at first thinner, afterward thicker and more glutinous. Their color and consistence are not always the same: instead of being transparent, they sometimes have a dirty, opaque appearance; at other times they assume a greenish, whitish, or yellowish color, and in some instances they bear a considerable resemblance to pus, which, it has been conjectured, might be owing to suppuration of some of the mucous follicles and a mixture of pus with its secretions. Mr. Thomas Bell, however, inclines to the opinion that it is attributable to an "alteration simply" of the secretions of the cavity. Their color and consistence are determined by the degree of inflammation; the length of time it has existed; the state of the health of the lining membrane, and that of the surrounding osseous walls; the egress which the matter has from the sinus; and the general habit of the body.

Affections of this sort are more common to young subjects than to middle-aged or persons in advanced life. An eminent French writer says that of three individuals affected with dropsy (mucous engorgement), the oldest was not twenty years of age.

Symptoms.—The diagnoses of the several affections of the antrum are so much alike, that it is often difficult to distinguish those that belong to one from those attendant upon another. The symptoms of mucous engorgement and purulent accumulation, however, are generally such as will enable the practitioner to distinguish, with considerable certainty, these from other affections. They are always preceded by inflammation of the lining membrane; a description of the symptoms of which, having already been given, need not be repeated. Omitting these, we at once proceed to mention those by which they are accompanied.

In speaking of the symptoms more particularly belonging to a purulent condition of the secretions of the antrum, Deschamps says the affection may be distinguished by dull, heavy pain, extending along the alveolar border. Upon this symptom alone little reliance can be placed, as it is always present in chronic inflammation. In addition to this he mentions the presence of decayed teeth; soreness in those that are sound; and, on the patient's inclining his head to the side opposite to the one affected, the discharge of fetid matter from the nose. These are very conclusive indications of purulent effusions in this cavity. Bordenave, after enumerating the symptoms indicative of inflammation, mentions the following as belonging to the affection of which we are now speaking: dull and constant pain in the sinus, extending from the maxillary fossæ to the orbit; a discharge of fetid

matter from the nose, when the patient inclines his head to the opposite side, or when the nose is blown from the nostril of the affected side. These symptoms are mentioned by almost every writer upon the subject, as indicative of a purulent condition of the secretions of the maxillary sinus.

The symptoms of engorgement differ materially from those which denote simply a purulent condition of the mucous secretions. The pain, instead of being dull and heavy, as just described, becomes acute, and a distressing sense of fullness and weight is felt in the cheek, accompanied by redness and tumefaction of the integument covering the antrum. The nasal opening, having become closed, the fluids of the cavity gradually accumulate until they fill it; when, finding no egress, they press upon and distend the surrounding osseous walls, causing those parts which are the thinnest ultimately to give way. The effects are generally first observable anteriorly beneath the malar prominence, where a smooth, hard tumor presents itself, covered with the mucous membrane of the mouth. But this is not always the point which first gives way; the sinus sometimes bursts into the orbit, at other times outwardly through the cheek, or through the palatine arch. The long-continued pressure thus exerted upon the bony walls often causes the breaking down or softening of their tissues.

The tumor, which is at first hard, becomes in a short time so soft as readily to yield to pressure. A distention, Deschamps says, may be distinguished from other diseases that affect the skin or subcutaneous tissues by the uniformity or regularity of the tumor, its firmness at the commencement, the slowness with which it progresses, and above all, by the natural appearance of the skin, and the absence of pain when pressure is made upon the tumor. Obliteration of the nasal opening, he says, may be suspected by the dryness of the nostril of the affected side, the mucous membrane of which becomes thickened and the cavity contracted, inflammation and sponginess of the gums, loosening and, sometimes, in consequence of the destruction of their sockets, displacement of the teeth, may also be mentioned as occasional accompaniments of engorgement.

Causes.—Inflammation of the mucous membrane is the cause of a purulent condition of the secretions of the maxillary sinus, and this arises more frequently from alveolo-dental irritation than from any particular habit of body or constitutional disturbance. Engorgement results from the obliteration of the nasal opening, which, in the case of altered secretion, is usually caused by inflammation and thickening of the lining membrane.

Treatment.—The curative indications of muco-purulent secretion and engorgement of the maxillary sinus are, firstly, if the nasal opening be closed, the evacuation of the retained matter; secondly, the removal of all local and exciting causes of irritation; thirdly, and lastly, the restoration of the lining membrane to its normal function.

For the fulfillment of the first an opening must be made into the antrum, and this should be effected in that part which will afford the most easy exit to the retained matter. Several ways have been proposed for the accomplishment of this object; and before we proceed further, it may not be amiss to notice some of the various methods that have been adopted by different practitioners.

With regard to the tooth most proper to be extracted, authors differ. Cheselden preferred the first or second molar. Junker recommended the extraction of the first or second bicuspid, and if a fistula had formed, to enlarge it instead of perforating the floor of the antrum. But the second molar, being directly beneath the most dependent part of the cavity, is the most suitable tooth to be removed. If this be sound, the first or third molar, or either of the bicuspids, if carious, may be extracted in its stead, and, in fact, no tooth beneath the antrum in an unhealthy condition should be permitted to remain. Heath recommends the extraction of the first molar on account of the depth of its socket, and because it is more liable to decay than any of the other teeth.

An opening having been effected through the palatine cavity of a molar tooth into the antrum, it should be kept open until the health of the cavity is restored. For this purpose, a sound, bougie, or canula adapted to the purpose may be introduced.

When the natural opening is closed, the first indication, as has been stated, is the evacuation of the matter; and for this purpose a perforation should be made into the sinus, and the most proper place for effecting this, it has been shown, is through the alveolar cavity of the second molar. It may. however, be penetrated from that of either of the other molars or bicuspids.

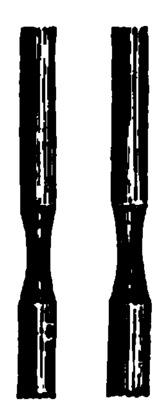
The perforation, after the extraction of the tooth, is made with a straight trocar, which will be found more convenient than those usually employed for the purpose. The point of the instrument having been introduced into the alveolus through which it is intended to make the opening, should be pressed against the bottom of the cavity in the direction toward the centre of the antrum. A few rotary motions of the instrument will suffice to pierce the intervening plate of bone.

Fig. 547 represents trephines for opening the antrum, either

through the palatine cavity of a second or first molar, or through the alveolus between these two teeth.

If the first opening be not sufficiently large, its dimensions may be increased to the necessary size by means of a spear-pointed instrument. The entrance is usually attended with a momentary severe pain, and the withdrawal of the instrument followed by a sudden gush of fetid mucus. In introducing the trocar, care should be taken to prevent a too sudden entrance of the instrument into the cavity. Without this precaution it might be suddenly forced against the opposite wall. It is not always necessary to perforate the floor of the antrum after the extraction of the tooth; it occasionally happens, as has already been remarked, that some of the alveolar cavities communicate with it.

FIG. 547.



An opening having thus been effected, it should be prevented from closing until a healthy action is established in the lining membrane, and for this purpose a bougie, or leaden or silver canula, or, still better, a small metal plate, fitted by impression and dies to the portion of the ridge about the opening, with a small tube attached to fill the aperture, to facilitate the flow of matter, syringing, and as a preventive to the premature closure of the opening, may be inserted into the spring and secured to one of the adjacent teeth. It should, however, be removed for the evacuation of the secretions at least twice a day. The formation of an opening at the base or most dependent part of the sinus will, in those cases where a fistula has been previously formed, be followed in most instances by its speedy restoration. Having proceeded thus far, the cure will be aided by the employment of such general remedies as may be indicated by the state of the general health; and for the dispersion of the local inflammation, leeches to the gums and cheeks will be found serviceable. The antrum may, in the meantime, be injected with, at first, some mild or bland fluid, and afterward with gently stimulating liquids. Diluted port wine, weak solutions of the sulphate of zinc and rose-water, copper and rose-water, or permanganate of potash, answer admirably, especially the latter, in the proportion of two grains to the ounce of water. Diluted tincture of myrrh may sometimes be advantageously employed, and when the membrane is ulcerated, a solution of nitrate of silver will be highly serviceable. The author has used a solution of iodide of potassium with advantage, also a weak alcoholic solution of tannic acid and diluted tincture of iodine. After the use of the permanganate of potash a carbolic solution, ʒj to water, ℥viij, or the antiseptic preparation, listerine, may be used

as an injection with decided benefit. The injection of a warm solution of salt and water is highly recommended as a preparatory step before making use of the permanganate of potash and the carbolic solution. For correcting the fetor of the secretions, a weak solution of the chlorinated soda or lime, or a solution of permanganate of potash may be occasionally injected into the antrum.

In cases of simple muco-purulent secretion, a weak decoction of galls may be injected into the sinus with advantage. Injections of a too stimulating nature are sometimes employed. This should be carefully guarded against, by making them at first weak, and afterward increasing their strength as occasion may require; and if symptoms of a violent character are by this means produced, they should be combated by applying leeches to the gums and fomentations to the cheek.

Dependent as these affections in most instances are upon local irritants, greater reliance is to be placed upon their removal and giving vent to the acrid puriform fluids, than on any therapeutical effects exerted upon the cavity by injections. As adjuvants, they are serviceable, but cure cannot be affected while the exciting cause remains unremoved.

Dr. Frank Abbott recommends a thorough washing out of the antrum, immediately after an opening is made into it, with a warm solution consisting of a teaspoonful of salt to half a pint of water, injected with slight force, and if there is still an offensive odor, to syringe with the permanganate of potash solution; then with the carbolic solution or with listerine; and as a dressing, to be renewed daily, carbolized oil (1 part of carbolic acid to 15 parts of oil of sweet almonds), on cotton, so applied that it may be retained in the antrum, and secured by attaching it to a tooth or to a plate worn in the mouth. If no improvement is apparent after two or three days, the antrum is to be syringed with a solution consisting of one drachm of carbolic acid, 1 ounce of tincture of iodine, and 8 ounces of water; and in some cases with a more powerful stimulant, such as 10 grains of chloride of zinc to 1 ounce of water. For systemic treatment, he recommends sulphide of calcium, one-tenth of a grain pill three times a day after meals, doubling the dose if necessary.

The following cases may serve to illustrate the treatment usually pursued in this disease.

Case 1.—Mrs. T., a married lady about 40 years of age, of a bilious temperament, applied to the author for advice in 1853. She had suffered from neuralgic pains in her face and temples at intervals for nearly twenty years, and as all of her teeth, especially of the upper jaw, were so much decayed as to preclude the possibility

of restoration, he urged their immediate removal. She submitted to the operation, hoping that it would relieve her from the pain to which she had so long been a martyr, and intending to have the lost organs replaced with an artificial set. She called again in a few months, partly for this purpose and partly to obtain relief from pain which she still experienced. It was not now so much diffused as formerly, but was almost wholly confined to the left side of the face. On inquiry it was ascertained that fetid matter was occasionally discharged from the nostril of the affected side. This led him to suspect that the antrum was diseased. An opening was accordingly made through the alveolar border at the point originally occupied by the second molar. The withdrawal of the instrument was followed by the discharge of a small quantity of purulent matter. The antrum was now forcibly injected with water. This caused the discharge of more than two tablespoonfuls of hardened flocculi from the left nostril, which, from long confinement, was insufferably offensive. The injection was repeated until the antrum was completely freed from this accumulation. A solution of sulphate of zinc, in the proportion of 6 grains to the ounce of water, was now substituted. The sinus was injected daily with this for a little more than a week, and without any other treatment a complete cure was effected.

The particulars of the following case are obtained from "Observations of Bordenave on the Diseases of the Maxillary Sinus," a paper embodying reports of forty highly interesting cases.

CASE 2.—"In 1756," says our author, "I was consulted by a lady whose right cheek was tumefied. About a month previously she had experienced acute pain under the orbit of the affected side, and she felt a pulsation and heat in the interior of the sinus, and the maxillary bone was slightly elevated. These signs determined me to propose the extraction of the first molar tooth and the perforation of the antrum through the alveolus. The operation was followed by a discharge of purulent matter, the sinus was afterward injected, the maxilla gradually reduced itself, and a cure was effected in about two months."

Although injections were employed in the above case, it was no doubt the escape of the matter contained in the antrum to which the cure was attributable. As regards the cause that gave rise to the affection in the first instance, not a single word is said. It may have resulted from inflammation lighted up in the sockets of one or more teeth, and propagated from thence to the mucous membrane of this cavity, or from inflammation produced by some other cause, and a consequent obliteration of the nasal opening.

The following brief statement is taken from the history of a case narrated by Fauchard.

CASE 3.—The child of M. Galois, aged twelve years, whose first right superior molar was decayed, had a tumor situated anteriorly upon the upper jaw of the same side, extending up to the orbit. M. Fauchard, supposing this tumor, which was about the size of a small egg, had been caused by the carious tooth in question, determined on its extraction as the only means of effecting a speedy and certain cure, and the result proved his opinion correct. The removal of the tooth was followed by a large quantity of yellow serous matter, which, on examination, was found to have escaped from the antrum. The tumor disappeared soon after the discharge of the matter and a complete cure was effected.

Bordenave, in noticing the foregoing case, does not believe that the tumor communicated with the maxillary sinus, for the reason that the matter escaped through the alveolus of the first molar immediately after its extraction. He, however, admits that the acumen and knowledge of Fauchard are such as to have prevented deception in the case. Admitting, then, the statement to be correct—and surely the circumstance mentioned by Bordenave does not in the least tend to invalidate it, for it is of frequent occurrence—a cure was effected simply by the removal of a decayed tooth, to the irritation produced by which the disease was undeniably attributable. The two following cases are described at length by the last-named author, in the "Mémoires de l'Académie Royale de Chirurgie."

CASE 4.—A girl, aged twenty-six years, had a very much decayed and painful superior dens sapientiæ on the right side extracted; the tooth was broken and all the roots but one were left in their sockets. These caused an abscess to form; and this was followed, for a short time, by a subsidence of the pain, which, however, soon returned, and a dull, heavy sensation was felt in the antrum of the affected side. From thence the pain extended to the eye and ear. The gums at length became tumefied and the pain less constant; the patient remained in this condition for five years, during which time five teeth were extracted. At this time (1756), M. Beaupreau, who was consulted, found, on examination, that the gums where the first tooth had been extracted had not entirely united, and a small tubercle had formed, from which a fluid of a bad smell and reddish color was discharging itself. He introduced a probe into the fistulous hole of the tubercle, which, after having overcome some obstacle that at first impeded its passage, penetrated the antrum. The opening was enlarged and mercurial water applied to the carious bone; but it soon closed, and the pain, which had ceased, returned. In-

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jections then were resorted to, which discharged themselves in part through the nasal opening, and the patient continued in this way until an exfoliation of the bone took place, when a cure was effected.

The cause of the disease in this, as in the preceding cases, was alveolo-dental irritation, and a cure would at once have been accomplished by the removal of the roots of the tooth that had been left in their sockets; this was proven by the fact that it was not until they were thrown off with their exfoliated alveoli that the disease was subdued.

In alluding to these and similar cases, Bordenave concludes there are not many cases where the extraction of teeth simply will suffice to effect a cure. This inference, to say the least of it, is unfair; for in the case last given the disease was attributable to the presence of the roots of a tooth that had been fractured in an attempt to extract it and left in their sockets, and we have good reason to believe that the cure was wholly owing to their removal.

Case 5.—Mr. G——, a laborer, about thirty years old, of a decidedly scorbutic habit, applied, in the spring of 1834, to an eminent physician of Baltimore, to obtain his advice concerning an affection of the left side of his face, under which he had been laboring for several months. The physician, after having examined the case, came to the conclusion that it was mucous engorgement of the maxillary sinus, and requested him to call upon us and have one of his molar teeth extracted and the floor of the antrum pierced through its alveolus. He at the same time desired that if his opinion in regard to the nature of the disease proved to be correct, we should take charge of the case altogether. On examining his mouth, we discovered that nearly all the teeth of both jaws, the gums, and alveoli were extensively diseased; and, on inquiry, obtained from him the following statement with regard to the commencement and progress of the affection.

About six months before this time, having been exposed, while pursuing his ordinary avocations, to very inclement and changeable weather, he contracted a severe cold; in consequence of this he was confined to his bed for several days, during which time he was twice bled, took two cathartics and other medicines.

The disease at first settled in his head, face, and jaws, but at the expiration of eight or ten days was subdued by the above treatment, with the exception of the pain in his left cheek and soreness in the upper teeth of the same side. The pain in his cheek, although not constant, still continued; the nasal cavity of that side ceased to be supplied with its usual secretion, the teeth became more sensitive to the touch; finally, at the end of four months, a slight protuberance

of the cheek was observable, accompanied by a tumor upon the left side of the palatine arch, which, when we first saw him, had attained to half the size of a black walnut; and it was by the fluctuation felt here that the physician whom he first consulted was induced to suspect the true nature of the disease.

Acting in consultation with the medical gentleman in whose care the patient had placed himself, we extracted the second left superior molar; then, through its alveolus, penetrated the antrum by means of a straight trocar, after the withdrawal of which a large quantity of glairy, fetid, mucous fluid was discharged. The perforation was kept open by means of a bougie, secured with a slight ligature to an adjoining tooth, as recommended by Deschamps, and the antrum injected three times a day, at first simply with rose-water, to which a small quantity of sulphate of zinc was afterward added. By this treatment the lining membrane of the antrum, at the expiration of five weeks, was restored to health, and the secretions that escaped through the perforation no longer exhaled a fetid odor.

The patient, not experiencing any inconvenience, withdrew the bougie and allowed the aperture to close. In about two months he again presented himself to the author similarly affected as when we first saw him. We now extracted the first superior left molar and perforated the antrum through the alveolus, and a quantity of fetid mucous fluid was again discharged; the dens sapientiæ and the first and second bicuspids of the affected side, being carious, were also extracted. Injections of sulphate of zinc and rose-water, diluted tincture of myrrh, diluted port wine, and a decoction of nutgalls were alternately employed for three months; at the expiration of this time the nasal opening, which had been previously closed, was re-established, and a perfect cure effected.

The condition of the teeth, in the case just narrated, may not be thought to have exerted any agency in the production of the affection of the antrum, but the following considerations would seem to justify a different conclusion. The presence of decayed teeth beneath the sinus may not only have contributed to aggravate the morbid action lighted up by the cold which he had taken, but may also have caused it to locate itself in this cavity; and the fact that the inflammation of the lining membrane and the obliteration of the nasal opening continued until they were removed, would, at least, seem to warrant such an inference. That the injections were beneficial we do not doubt, but that the cure was effected by them no one, we think, will dare to affirm. We are far from believing that the presence of the decayed teeth was the sole cause of the disease of the antrum; that they contributed to and protracted it we cannot hesitate to believe; still, but

for the increased excitability, and, perhaps, actual inflammation, induced in the mucous membrane by the exposure of the patient to inclement and sudden transitions of weather, it is probable the sinus would never have become affected. But, on the other hand, we think it not unlikely that, although the disturbance may have originated from this cause, no very serious or lasting morbid effect would have been produced if the teeth and alveoli had been in a perfectly healthy condition.

The particulars of the following highly interesting case were communicated to the author by Dr. L. Roper, of Philadelphia, in a conversation which he had with him in 1845.

Case 6.—Miss M——, a young lady from the West Indies, about fourteen years of age, had a fistulous opening beneath the right orbit, communicating with the maxillary sinus. By means of a probe introduced through the opening into this cavity, the apices of the roots of the first superior molar could be distinctly felt.

Medical aid was sought at an early stage of the disease, but as no permanent benefit resulted from the treatment adopted, the young lady, at the expiration of nine months, was brought by her father to Philadelphia, and, in the spring of 1831, placed under the care of the late Dr. Physick. He, suspecting that the affection of the antrum had resulted from and was still kept up by irritation produced by the first superior molar of the affected side, which was considerably decayed, directed her to be taken to Dr. Roper, who, concurring with him in opinion, at once extracted the carious tooth. The operation was followed by the immediate discharge of a large quantity of thick, muddy, and greenish matter. The fistula under the orbit soon closed, and, without any further treatment, a perfect cure was accomplished in the course of a few weeks.

The foregoing are all the particulars which we could obtain concerning this interesting case. Wé have no doubt that, if all the circumstances connected with its early history were known, it would be found to have resulted from inflammation of the lining membrane of the antrum, caused by irritation in the socket of the tooth which was extracted. This opinion is sustained by the fact that this tooth was affected with caries, and that its removal was followed by the immediate cure of the disease.

In Bordenave's collection of cases of disease of the maxillary sinus, published in the Memoirs of the Royal Academy of Surgery, there are several examples similar to the one just narrated. We subjoin a description of the two following:—

Case 7.—A servant of the Count de Maurepas had been afflicted for six months with a fistula upon the left cheek, a little below the

orbit, penetrating to the maxillary sinus, and caused by the spontaneous opening of an abscess. The first and second molars, both of which were considerable decayed, were extracted by M. Hevin. As there were no openings through the alveoli, he perforated one with a trocar; this opening gave vent to a great quantity of putrid sanies, and did not close for more than year after it was made. The fistula of the cheek healed in about ten days.

CASE 8.—In 1717, a soldier of the regiment of Bassigny, who had for a long time a fistula in his cheek penetrating into the maxillary sinus, was treated for it at the Hôtel Dieu, of Montpellier. The matter settling near the orifice of the fistula prevented it from closing. M. Lamourier, on examining the mouth of the soldier, perceived that the second superior molar was decayed; this he extracted, and profited by the alveolar cavity to make an opening into the base of the sinus. The fistula of the cheek was by this means cured in a few days, but the counter opening was not immediately permitted to close.

In cases of fistula resulting simply from engorgement of the sinus, the treatment should consist, as in the foregoing cases, in the formation of a counter opening, which should always be effected at the most dependent part of the cavity; and next in the removal of all sources of local irritation; lastly, in the employment of suitable injections.

In the cases thus far presented, we have selected such as were not complicated with abscess, ulceration of the lining membrane, or caries of the surrounding osseous walls; but to the existence of the two last, the affections of which we have been treating, often give rise. For tumors, etc., of the antrum, the reader is referred to "Tumors of the Gums."

CHAPTER X.

CARIES OF THE MAXILLARY BONES.

CARIES of the maxillæ, like necrosis, is not a very common disease, and differs from the latter in being analogous to ulceration in the soft parts, and in being free from the odor, when cleanliness is observed, which characterizes necrosis.

The symptoms of caries of bone resemble those of alveolar abscess, and when the acute form of the disease is present, it is associated with inflammation of the gums and dental periosteum; periostitis being early manifested when the carious condition of the bone

results from diseased teeth. When caries of the maxillæ is well established, one or more fistulous openings exist in the gum or in some adjacent part; these openings being surrounded, in the majority of cases, by fungous granulations. The bone beneath is full of minute cells, and is of a soft consistence—a condition readily detected by the probe or an excavator, and differing very materially from the solid, resisting structure presented by bone when in a normal condition. Commencing like ordinary periostitis, there is present, in the early stage, increased vascularity and congestion, which terminates in ulceration; the bone cells becoming enlarged by the breaking down of their walls, and filled with semi-organized lymph, the accumulation of which is attended with a rapid advance of the destructive process. The numerous irregular cavities existing in the bone are lined by a glazed secreting surface. According to Virchow, "the bone breaks up in its territories, the individual corpuscles undergo new developmental changes (granulation and suppuration), and remnants composed of the oldest basis substance remain in the form of small, thin shreds in the midst of the soft substance. In ossification (in cartilage) there is a portion of the original intercellular substance of the cartilage cells (secondary cells), which though it belongs to the group as a whole, yet, when these, in the course of ossification, are transformed into a number of isolated bone cells, becomes, comparatively speaking, almost entirely independent of those cells individually, and therefore escapes the changes which befall them."

It is this portion which remains behind the caries, while the secondary intercellular substance perishes. "At the moment a periosteal tissue quits the surface of a bone, and the vessels are drawn out from the cortex in inflammatory condition, we see, not as in normal bone, mere threads, but little plugs, thicker masses of substance; and if they have been entirely drawn out, there remains a disproportionately large hole, much more extensive than it would be under normal circumstances. On examining one of these plugs you will find that around the vessel a certain quantity of soft tissue lies—the cellular elements of which are in a state of fatty degeneration. At the spot where the vessel has been drawn out, the surface does not appear even, as in normal bone, but rough and porous; and when placed under the microscope you remark those excavations, those peculiar holes, which correspond to the liquefying bone territories. If it be asked, therefore, in what way bone becomes porous in the early stage of caries, it may be said that the porosity is certainly not due to the formation of exudations, seeing that for these there is no room, inasmuch as the vessels within the medullary

canals are in immediate contact with the osseous tissue. On the contrary, the substance of the bone in the cellular territories liquefies; vacuities form, which are first filled with a soft substance, composed of a slightly streaky connective tissue, with fatty degenerated cells. The whole process is a degenerative ostitis, in which the osseous tissue changes its structure, loses its chemical and morphological character, and so becomes a soft tissue, which no longer contains lime."

In the early stages of caries of the maxillæ, there is nothing to distinguish it from dental periostitis, and although the causes of this disease are various, yet one of the most common is the presence of dead teeth and roots of teeth, and the superior maxilla is much more prone to its attacks than the inferior, and especially where the bone is of a loose, spongy character, as in the strumous and mercurial diathesis. In cases of ulceration and extensive destruction of the tissues of the face, resulting from syphilis or lupus, the maxillary bones may become carious, and terrible deformity follow, as in cases where it commences in the palate, and destroying it, makes a common cavity of the mouth and nose, and involves the face.

Treatment.—In the early stage of the acute form of caries of the bones of the jaws, such antiphlogistic remedies as cathartics, diaphoretics, hot foot baths, leeches and counter-irritants may be resorted to. If a diseased tooth or teeth give rise to the inflammation, such should be removed if they cannot be successfully treated. Blood taken from the arm, and also dry cups, are often serviceable. If a depraved condition of the system is present, as is frequently the case, the disease being of an asthenic type, such constitutional remedies as iron, quinine, cod-liver oil, and like tonics are indicated; and when the caries is established, injections of aromatic sulphuric acid in full strength, or the officinal sulphuric acid, one part to six or eight parts of water, or, when required, in equal parts, will dissolve the carious bone, relieve the irritation caused by its presence, and hasten the cure, having a stimulant effect upon diseased tissues, and exerting an antiseptic influence. Listerine may also be employed for its antiseptic properties in conjunction with the aromatic sulphuric acid, no other remedy proving so satisfactory in the treatment of this disease as the latter agent. Other agents, in the form of injections, have also been recommended, such as carbolic acid solution, tincture of iodine, compound tincture of capsicum and chloride of zinc.

The removal of the carious bone is often necessary by such appli-

ances as rose-head drills, made for the purpose and operated by the dental engine, chisels, etc.

An incision is first made to expose the bone, and the carious portion is then cut away with the rose-head drill or chisel, causing but little pain, until normal structure is reached, which is easily distinguished by the difference in touch of the instrument. Comparatively slight hemorrhage occurs, as a general rule, and it is readily controlled by such styptics as a saturated solution of chloride of zinc, Monsel's powder, or compression by means of hot sponges. In employing injections in the treatment of well-established caries of bone, great benefit results from the preparatory cleansing of the parts with warm water, and its use should never be omitted.

PART FOURTH.

MECHANICS.—DENTAL PROSTHESIS.

MECHANICS.

THIS branch of dental science teaches the art of replacing lost organs of the Mouth, or any lost parts thereof. It is now generally called Dental Prosthesis (replacement). Mechanical detail is its prevailing feature; substitution or replacement is its distinctive peculiarity.

Mechanical detail also distinguishes the Surgery of dentistry as compared with general surgery; but as a branch of dentistry, therapeusis, or the arrest of disease, is its distinctive peculiarity.

The one treats disease or irregularity of the natural organs; the other substitutes their loss by artificial ones. Both demand a skillful training of the hands, and equally require, for their fullest development, all the knowledge comprehended under the term Dental Science.

Dental Prosthesis includes the laws and principles which determine and regulate the processes employed in the construction of all forms of dental mechanism; also the properties and relations of all materials used in these processes. It gives rules for the replacement of—

1. Lost teeth.
2. Lost alveoli, or parts thereof.
3. Lost palate, hard and soft, or parts thereof.

The first division is the most important, because the most universally demanded.

The following is the order of operations in the REPLACEMENT OF LOST TEETH, and classification of the various styles of work :—

1. Preparation of the mouth; including
   (a) Treatment of the mucous membrane.
   (b) Extraction or treatment of teeth and roots.
2. Impression of the mouth; including
   (a) Form and material of impression cups.
   (b) Description of impression materials.
   (c) Selection and manipulation of the same.
   (d) Preparation for the model.
3. The plaster model; including
   (a) General directions for making model.
   (b) Special forms adapted to subsequent uses.
   (c) Removal from impression.
   (d) Preparation for the operation of making the plate.

4. The base-plate; which is either
 (*a*) Permanent, in swaged work, or
 (*b*) Temporary, in plastic work.

The subsequent operations differ in their order and character so widely as to require a separate classification in

(A) Swaged work:—
 (1) Metallic die and counter-die, made by
  (*a*) Sand moulding;
  (*b*) Dipping, or pouring;
  (*c*) Fusible metal process, or by
  (*d*) Pouring directly into the impression.
 (2) Refining and rolling plate.
 (3) Swaging plate (gold, silver, platinum, or aluminum).
 (4) Articulating impressions.
 (5) Adjustment on articulator.
 (6) Selection and fitting of teeth, and
 (7) Attaching them to base-plate, by
  (*a*) Soldering;
  (*b*) Vulcanite; Celluloid;
  (*c*) Porcelain continuous gum.
 (8) Finishing process.

(B) Plastic work:—
 (1) Temporary plate of
  (*a*) Wax, or gutta-percha;
  (*b*) Thick tin, or lead, foil.
 (2) Articulating impressions.
 (3) Adjustment on articulator.
 (4) Selection and fitting of teeth.
 (5) Preparation of the matrix.
 (6) Moulding and hardening of the base-plate, made of
  (*a*) Vulcanite compounds, which harden by heat;
  (*b*) Celluloid compounds, which harden by heat;
  (*c*) Molten tin and other alloys, which harden on cooling;
  (*d*) Molten and swaged aluminum;
 (7) Which process at the same time attaches the teeth.
 (8) Finishing process.

The details of Swaged work vary according to the mode of making dies, the metal chosen for the plate, and the manner of attaching the teeth; but the order of operations is the same. The details of Plastic work vary also, according to the material composing the plate; but the order of operations is the same—differing from the former mainly because articulation follows the formation of the bone-plate in one case, while in the other it precedes it.

These differences in the material of the base-plate give rise to a classification of Swaged work into

1. Gold plate;
2. Aluminum plate;
3. Platinum plate.

The first (and third) allows attachment of the teeth by soldering; the second demands a vulcanite attachment; the third alone permits, by virtue of its resistance to furnace heat, the addition of a continuous porcelain gum.

Plastic work is divided into

1. Vulcano-plastic;
2. Cellulo-plastic;
3. Metallo-plastic;
4. Ceramo-plastic;

The first is known as rubber work; the second is known as celluloid work; the third includes cheoplastic work, the old-fashioned block-tin base, all tin alloys and cast aluminum, etc.; the fourth is known as the porcelain base.

In Prosthetic dentistry, swaged work is the patrician element; plastic work, the plebeian. When the latter runs riot, without the conservative influence of the former, the power of the people becomes a power for evil. This is precisely the danger which now threatens dentistry, in the abuse of certain most valuable processes and materials.

Facility of construction and cheapness of material have encouraged a style of practice in the highest degree detrimental to the profession. If such practice is inseparable from plastic work, it should be unhesitatingly abandoned by every one who holds the honor of dentistry dear to him. It becomes, also, a grave question how far the present mania for patents (another abuse of a valuable privilege) is beneficial to the reputation of a liberal profession.

CHAPTER I.

DENTAL PROSTHESIS.

Contributing, as the teeth do, to the beauty and expression of the countenance, to correct enunciation, and, through improved facility of mastication, to the health of the whole organism, it is not surprising that their loss should be considered a serious affliction, and that art should be called upon to replace such loss with artifi-

cial substitutes. So great, indeed, is the liability of the human teeth to decay, and so much neglected are the means of their preservation, that few persons at the present day reach even adult age without losing one or more of these invaluable organs. Happily for suffering humanity, they can now be replaced with artificial substitutes so closely resembling the natural organs as to be readily mistaken for them, even by critical and practiced observers. Although there is a perfection in the work of nature that can never be equaled by art, artificial teeth are now so constructed as to subserve, at least to a great extent, the purposes of the natural organs. When properly adjusted, they are worn without the slightest discomfort; so much so, in many cases, that the patient, after they have been in the mouth a few weeks, is scarcely conscious of their presence.

The construction of artificial teeth is an operation which, though acknowledged to be of great importance, and performed by every one having any pretension to a knowledge of dentistry, is, unfortunately, but little understood by the majority of practitioners. The mouth is often irreparably injured by their improper application. A single artificial tooth, badly inserted, may cause the destruction of the two adjacent natural teeth or those to which the artificial appliance is secured; and if the deficiency thus occasioned be unskillfully supplied it may cause the loss of others; in this way all the teeth of the upper jaw are sometimes destroyed.

The utility of artificial teeth depends upon their proper construction and correct application. There is no branch of dental practice that requires more skill and judgment or more extensive and varied scientific information. A knowledge of the anatomy and physiology of the mouth, of its various pathological conditions and their therapeutical indications, is as essential to the mechanical as to the surgical dentist. To correct information upon these subjects must be added the ability to execute, with the nicest skill and most perfect accuracy, all the mechanism required in dental prosthesis.

There are difficulties connected with the insertion of artificial teeth of which none but an experienced dentist has any idea. They must be constructed and applied in such a manner that they may be easily removed and replaced by the patient; at the same time they must be securely fixed in the mouth and be productive of no injury to the parts with which they are in relation.

But perfect mechanism is not the sole element of success; often it is not the most essential one. To know when to extract and when to retain a root or a tooth; when to secure a piece by clasps and when by simple adaptation; when to use gold and when some other

material; to determine the best form of a plate and the proper time for its insertion; finally, to determine when and what prosthetic skill can do, when and why it will fail—are a few of the problems in dental mechanics which demand for their correct solution a fullness and extent of information which are not always brought to bear, perhaps because, unfortunately, the necessity is not recognized as it should be.

Notwithstanding the triumphs of prosthetic dentistry and the high state of excellence to which it has arrived, at no previous time was there ever so much injury inflicted and suffering occasioned by artificial teeth as at present, resulting solely from their bad construction and incorrect application. That such should be the case when there are so many scientific and skillful dentists in every city and in many of the villages of the country may seem strange, but the fact is nevertheless undeniable. We may explain it in part by the very rapidly increasing demand for dental services, which has not allowed time for the development of intelligent and skilled labor, either of head or hand; in part, also, by the universal experience that all new professions are full of immature and crude material. But these explanations cannot long be received in excuse for a state of things which ought to be rapidly disappearing—which is, in fact, giving way under the combined influence of our colleges, our periodicals, and text-books, the teachings and example of our eminent practitioners, and the more appreciative judgment of the public.

These remarks apply alike to the surgery and mechanism of dentistry. The latter has an additional barrier to progress in the common practice of delegating the greater part of its details to inexperienced, uninformed, and irresponsible assistants. Perfect dentistry demands equal skill and education in both departments. Each requires that its complete series of operations shall be the work of one person. If, therefore, the work of the two are so far incompatible that they cannot be combined, the separation should be complete. The semi-mechanism of the surgeon is like the semi-surgery of the mechanism. Each injures an otherwise perfect reputation; both do harm to the profession they seek to honor.

In an excellent article on "Temperament in Relation to the Teeth,"* Dr. James W. White writes as follows:—

"The value of a practical application of the study of temperament in the practice of dentistry is apparent. That the relation of the teeth to temperament is, as a rule, ignored by those engaged in pros-

* *Dental Cosmos*, February, 1884.

thetic dentistry is evident in the mouths of a majority of those who are so unfortunate as to be under the necessity of wearing substitutes for lost natural dentures.

"A certain law of harmony in nature between the teeth and other physical characteristics necessitates respect to size, shape, color, and other qualities in an artificial denture, in order that it shall correspond with other indications of temperament; and if teeth correlated in their characteristics to those which nature assigns to one temperament be inserted in the mouth of one whose physical organization demands a different type, the effect is abhorrent. The artificiality of artificial teeth is the subject of remark by those who have little or no conception of the reason therefor—simply an instinctive appreciation of the incongruity and unreality. It is, indeed, rare to see a case in which there is occasion for a moment's hesitation as to the fact of replacement. There is no dental service that, from the æsthetic standpoint, is, as a rule, so ill performed as the prosthetic. Thousands of dentures are constructed which serve the needs of the wearer for speech and mastication, but which are nevertheless deserving of utter condemnation as art productions. More attention has been paid to the best methods of restoring impaired function—securing comfort and usefulness in artificial dentures—than to a correlation of the substitutes to the physical characteristics of the patient.

"What is needed is such an appreciation of the law of correspondence that the dentist can cipher out, as by the rule of three, the character of teeth required in the case of an edentulous mouth, with the same precision as the comparative anatomist can from a single bone indicate the anatomical structure of the animal to which it belonged."

We shall enumerate some of the different kinds of dental substitutes that have been employed since the commencement of the present century. We shall also notice briefly the principal methods that have been adopted in their application, before entering upon a minute description of those practiced at the present time. Great improvements have been made in dental prosthesis since the publication of the former editions of this work. In fact, no science or art, except chemistry, has been so eminently progressive during the last twenty years as mechanical dentistry.

CHAPTER II.

SUBSTANCES EMPLOYED AS DENTAL SUBSTITUTES.

THERE are two qualities which it is highly important that dental substitutes should possess. They should be durable in their nature, and in their appearance should resemble the natural organs which they replace or with which they are associated.

The kinds of teeth that have been employed since 1820 are—

1. Human teeth.
2. Teeth of neat cattle, sheep, etc.
3. Teeth carved from the ivory of the elephant's tusk and from the tooth of the hippopotamus.
4. Porcelain teeth.

HUMAN TEETH.

As regards appearance, which in a dental substitute is an important consideration, human teeth are preferable to any other, except, perhaps, the almost perfect recent productions of the dento-ceramic art. When used for this purpose, they should be of the same class as those the loss of which they are to replace. The crowns only are employed, and if well selected and skillfully adjusted the artificial connection with the alveolar ridge cannot easily be detected.

The durability of these teeth when thus employed depends upon the density of their texture, the soundness of their enamel, and the condition of the mouth in which they are placed. If they are of a dense texture, with sound and perfect enamel, and are placed in a healthy mouth, they will last from eight to twelve years, or even longer. The difficulty, however, of procuring these teeth is generally so great that it is seldom that such as we have described can be obtained; and even when they can, the mouth, in half the cases in which artificial teeth are placed, is not in a healthy condition; its secretions are often so vitiated and of so corrosive a nature, that they destroy them in less than four years. We have even known them to be destroyed in two, and in one case in fifteen months.

A human tooth artificially applied is more liable to decay than one of equal density having a vital connection with the general system, for the reason that its dentinal structure is more exposed to the action of deleterious chemical agents. Yet of all the animal substances employed for this purpose, human teeth are unquestionably the best. They are harder than bone, and being more perfectly protected by enamel, are consequently more capable of resisting the action of corrosive agents.

Many object to having human teeth placed in the mouth, under the belief that infectious diseases may be communicated by them. But the purifying process to which they are previously submitted greatly diminishes this danger. When the practice of transplanting teeth was in vogue, occurrences of this sort were not unfrequent; but since that has been discontinued, these have seldom if ever happened. Still, the prejudice against human teeth is so strong that it is impossible, in most cases, to overcome it. This feeling, the difficult of procuring them, the high price they command, and their want of durability, have gradually led to their entire disuse, which is scarcely to be regretted, now that art can produce in porcelain such accurate imitations of nature. The only case in which we might feel called upon to insert natural teeth is where any of the twelve front teeth become loosened by periosteal disease and drop from their sockets while yet perfectly free from caries. These teeth may often be adjusted to a plate so as to present an exceedingly natural appearance.

TEETH OF CATTLE.

Of the various kinds of natural teeth employed for dental substitutes, those of neat cattle are, perhaps, after human teeth, the best. By slightly altering their shape they may be made to resemble the incisors of some persons; but a configuration similar to the cuspids cannot be given to them, and in most cases they are too white and glossy. The contrast, therefore, which they form with the natural organs should constitute, were they in all other respects suitable, a very serious objection to their use. Imitation of nature has been too much disregarded, both by dentists and patients. Indeed, many of those who need artificial teeth wish to have them as white and brilliant as possible, and some practitioners lack either the decision or the judgment to refuse compliance with a practice which destroys all that beauty and fitness which it is the aim of dental æsthetics to cultivate.

There are other objections to the use of these teeth. In the first place, they are only covered anteriorly with enamel; in the second, their dentinal structure is less dense than that of human teeth, and, consequently, they are more easily acted on by chemical agents. They are, therefore, less durable, seldom lasting more than from two to four years. Another objection to their use is, they can be employed in only the very few cases where short teeth are required, owing to the large size of their nerve cavities. It is seldom, therefore, that they can be advantageously used as substitutes for human teeth.

IVORY OF THE ELEPHANT AND HIPPOPOTAMUS.

Artificial teeth made from the ivory of the tusk, both of the elephant and hippopotamus, have been sanctioned by usage from the earliest periods of the existence of this branch of the art. We must not hence conclude that it has been approved by experience; on the contrary, of all the substances that have been used for this purpose this is certainly the most objectionable.

The ivory of the elephant's tusk is decidedly more permeable than that obtained from the hippopotamus. So readily does it absorb the buccal fluids that, in three or four hours after being placed in the mouth, it becomes completely saturated with them. Consequently, it is not only liable to chemical changes, but the absorbed secretions undergo decomposition; and when several such teeth are worn, they affect the breath to such a degree as to render it exceedingly offensive. Again, on account of its softness, teeth are easily shaped from it; but, not being covered with enamel, they soon become dark, and give to the mouth a repulsive appearance. Fortunately, however, in the United States elephant's ivory is rarely used, either as a base-plate or for the teeth themselves.

The ivory of the tusk of the hippopotamus is much firmer in its texture than that obtained from the elephant; being covered with a hard, thick enamel, teeth may be cut from it which, at first, very closely resemble the natural organs. There is, however, a peculiar *animation* about human teeth, which those made from this substance do not possess; moreover, they soon change their color, assuming first a yellow, and then a dingy bluish hue. They are, also, like elephant ivory, very liable to decay. We have in our possession a number of blocks of this sort, some of which are nearly half destroyed. The same objection lies against teeth made from the hippopotamus ivory, sufficient to condemn its use. Like those formed from elephant ivory, they give to the breath an offensive odor, which no amount of care or cleanliness can wholly correct or prevent.

PORCELAIN OR INCORRUPTIBLE TEETH.

The manufacture of porcelain teeth did not for a long time promise to be of much advantage to dentistry. But through the ingenuity and indefatigable exertions of a few, they have, within the last thirty years, been brought to such perfection as to supersede all other kinds of artificial teeth.

The French, with whom the invention of these teeth originated, encouraged their manufacture by favorable notices; and the rewards offered by some of the learned and scientific societies of Paris con-

tributed much to bring it to perfection. They were still, however, deficient in so many particulars that they received the approbation of very few of the profession, and then only in some special cases. It is principally to American dentists that we are indebted for that which the French so long labored in vain to accomplish.

A want of resemblance to the natural organs, in color, translucency and animation, was the great objection urged against porcelain teeth: and, had not this been obviated, it would have constituted an insuperable objection to their use. Until 1833 all that were manufactured had a dead, opaque appearance, which rendered them easy of detection when placed beside the natural teeth, and gave to the mouth an unnatural aspect. But so great have been the improvements in their manufacture that few can now distinguish between the natural teeth and their artificial companions, if well selected and skillfully applied.

The advantages which mineral teeth possess over every sort of animal substance are numerous. They can be more readily secured to the plate and are worn with greater convenience. They do not absorb the secretions, and, consequently, when proper attention is paid to their cleanliness they do not contaminate the breath or become in any way offensive. Their color never changes. They are not acted on by the chemical agents found in the mouth, and hence the name *incorruptible*, which has been given them.

Porcelain teeth are divided into single, sectional, carved-block, continuous gum, and pivot-crown teeth, all of which consist of a body and enamel.

The body or base is composed of silex, feldspar, and kaolin, while the enamel is principally composed of feldspar, and is colored by means of metals in a state of minute division, or in the form of oxides. The principal metals employed for this purpose, and which give the positive tints, are gold, platinum, and titanium. Gold, in a state of fine division, imparts a rose-red tint; the same metal, in the form of an oxide, gives a bright rose-red tint. Platinum, in the form of sponge and filings, imparts a grayish-blue tint. Titanium, in the form of an oxide, imparts a bright yellow tint. Other metals, in the form of oxides, are also employed to color porcelain teeth, such as uranium, which gives a greenish-yellow tint; manganese, a purple tint; cobalt, a bright blue tint; silver, a lemon-yellow tint; zinc, also a lemon-yellow tint; and purple of Cassius, a rose-purplish tint. By combining the tints, using some to soften others, the different shades of color required to impart character and a life-like appearance to artificial teeth are obtained.

The vast extension of mechanical practice is due, more than to any other one cause, to these improvements in the manufacture of porcelain teeth—improvements essentially American, and so important as fairly to justify a little of that boasting spirit which, transplanted from the mother country, has attained such luxuriant growth on American soil.

The beautiful exact imitation of the varying shades of the natural gum, which as yet has been found possible only in porcelain, would of itself give to this material a claim over every other. All attempts to color ivory have failed to produce any permanent results. More recent experiments in the several vulcanizable materials have thus far given opaque and lifeless colors, which no stretch of imagination can compare with the natural gum, the nearest approach to a proper color being the celluloid base. When a material shall have been discovered possessing the valuable properties of the vulcanite combined with the beauty of a porcelain artificial gum, dental prosthesis will have nearly reached perfection.

Dr. James W. White, in a popular treatise on "The Teeth," remarks: "The observant dentist will take into the account complexion, age, sex, height, the color of hair and eyes, and other characteristics of the individual, when selecting teeth to replace lost ones; and the manufacturer should be skilled in the observance of the varied classes of denture required. To inattention in this direction on the part of the dentist, or to dictation on the part of the patient, is to be charged the unseemly incongruities constantly staring the observer in the face, from mouths whose lost organs have been replaced in disregard of this universal law. No matter how anatomically correct or how skillfully adapted for speech and mastication an artificial denture may be, yet if it bear not the relation demanded by age, temperament, facial contour, etc., it cannot be otherwise than that its artificiality will be apparent to every beholder. Artificial teeth should be natural as to shape, color, and vital appearance; there should be a nice blending of the colors of the body and enamel, not an abrupt union of the two; there should be the precise amount of translucency and the peculiar texture of the surface; and these characteristics should be maintained by artificial light as well as by daylight; for many teeth which in daylight look reasonably well have an artificial appearance when exposed in the mouth to an artificial light. They should also possess strength sufficient for the uses for which they are designed. Besides all this, there must be taken into the account the varying forms of the jaws or maxillary ridge, so that the dentist may be enabled to select teeth which are adapted to each particular case, and which

can be made to articulate nicely with other or with the natural teeth, if there are any remaining in the mouth; otherwise his best efforts will not secure a good appearance, comfort to the wearer, or usefulness in mastication."

CHAPTER III.

RETENTION OF ARTIFICIAL TEETH.

THE methods of retaining artificial teeth in place are—first, by pivoting to the natural roots; second, by attaching to metallic or other kind of base-plate, secured either by, 1, clasps; 2, spiral springs, or; 3, atmospheric pressure. The peculiar advantages of each of these methods we shall now proceed to point out, and the cases to which they are particularly applicable.

ARTIFICIAL TEETH PLACED ON NATURAL ROOTS.

This method of securing artificial teeth was formerly, on account of its simplicity, more extensively practiced than any other; and, under favorable circumstances, it answers as well as any that can be adopted. If the roots on which they are placed be sound and healthy, and the back part of the jaws supplied with natural teeth, so as to prevent those with which the artificial antagonize from striking them too directly, they will subserve the purposes of the natural organs more perfectly than any other description of dental substitute, and can be made to present an appearance so natural as to escape detection upon the closest scrutiny. If properly fitted and secured, not only is their connection with the natural roots not easily detected, but they may render valuable service for many years.

The pivoting of the lower incisors, from their small size and the dangerous sequelæ of abscess, is frequently an unsatisfactory operation. Many upper laterals are also too small to admit a pivot. In practice the pivoting of cuspids is seldom called for. These teeth being very persistent, their loss usually implies that of many, perhaps all, others, and the entire deficiency is replaced by teeth attached to a base-plate.

The insertion of an artificial tooth on a diseased root, or on a root having a diseased socket, is almost always followed by injurious consequences. Filling the root, together with proper accompanying treatment, will sometimes so completely arrest disease as to

make pivoting safe; but there is always risk in these cases. The morbid action already existing in the root or its socket is aggravated by the operation, and often caused to extend to the contiguous parts, and occasionally even to the whole mouth. Even in a healthy root it is not always proper to apply a tooth immediately after having prepared the root. If any irritation is produced by this preparatory process, the tooth should not be inserted until it has wholly subsided. The neglect of this precaution not unfrequently gives rise to inflammation of the alveolo-dental periosteum and to alveolar abscess.

Apart from the condition of the root, the question of pivoting—or of a plate tooth without gum resembling a pivot tooth—may depend upon the adjoining tooth or roots. If in any space to be supplied one root is absent all should be extracted, for the peculiar beauty of a pivot tooth is lost if its neighbor has an artificial gum.

Although this method of securing artificial teeth has received the sanction of the most eminent dental practitioners, and is one of the best that can be adopted for replacing loss in the six upper front teeth, yet, on account of the facility with which the operation is performed, it is often resorted to under the most unfavorable circumstances, in consequence of which the method has been undeservedly brought into discredit. Apart from the proneness of operators to resort to this method when its adoption is unjustifiable, we may name two objections to the use of pivot teeth as formerly prepared and inserted. First, the difficulty of preventing the presence of secretions between the crown and root, which make the breath offensive and cause the root gradually to decay. Secondly, the more or less rapid enlargement of the canal, requiring frequent replacement and the ultimate loss of the root. The more recent methods, however, many of which consist in improvements upon the older methods, have obviated these objections in a great measure.

The efforts of the economy for the expulsion of the roots of the bicuspid and molar teeth after the destruction of their lining membrane, are rarely exhibited in the case of roots of teeth occupying the anterior part of the mouth. This circumstance has led us to believe that the roots of these teeth receive a greater amount of vitality from their investing membrane than do the roots of those situated further back in the mouth; and that the amount of living principle thus supplied is sufficient to prevent them from becoming manifestly obnoxious to their sockets.

Another explanation assumes the equal vitality of all the roots, and attributes the persistence of front roots, upon which a crown has

been placed, to the continuance of that pressure to which it was subject so long as it had its natural crown. It is asserted in maintenance of this view, that front roots left to themselves will disappear in the same manner as bicuspid and molar roots, and that the latter may be retained if the artificial crown (attached to a plate) is set upon them; also, that the process of expulsion is analogous to that by which a tooth is elongated which has lost its antagonist.

It is well known that a dead root is always productive of injury to the surrounding parts, and that nature calls into action certain agencies for its expulsion. Therefore, attaching a tooth to a completely dead root is manifestly improper; but the roots of the front teeth are rarely entirely deprived of vitality, and hence, after the destruction of their lining membrane, they remain often ten, fifteen, and sometimes twenty years without very obviously affecting the adjacent parts.

Teeth, attached to a plate, and resting upon natural roots which are in as healthy condition as it is possible for such roots to be, have all the beauty whieh so strongly recommends pivot teeth. They are not so securely held in position; but the ability to remove them is in itself an advantage. This method is applicable in many cases where the drilling for a pivot is impossible. The reader is referred to the chapter describing the different methods of pivoting teeth.

THE ARTIFICIAL TEETH SECURED BY CLASPS.

This method of securing artificial teeth, first introduced by the late Dr. James Gardette, of Philadelphia, is, perhaps, in favorable cases, one of the firmest and most secure that can be adopted. By this means, the loss of a single tooth, or of several teeth, may be supplied. A plate may be so fitted to a space in the dental circle and secured with clasps to other teeth as to afford a firm support to six, eight, or ten artificial teeth.

Teeth applied in this way, when properly constructed, will last for several years, and sometimes during the life of the individual. But it is essential to their durability that they should be correctly arranged, accurately fitted, and firmly secured to the plate; that the plate itself be properly adapted to the gums, and the clasps attached with the utmost accuracy to teeth firmly fixed in their sockets.

Gold is perhaps the best material that can be employed for both plate and clasps. Since the application of vulcanized rubber to dental purposes, plates of this latter material with gold clasps attached have been much used. When gold is employed for the plate it should be from 20 to 21 carats fine, and from 18 to 19 for the clasps.

If gold of an inferior quality is used, it will be liable to be acted on by the secretions of the mouth. Platina perfectly resists the action of these secretions, and would, perhaps, answer the purpose as well as gold were it not for its softness and pliancy; in full cases, and in some partial cases, the shape of the plate may more or less overcome this difficulty, especially when, as in the continuous gum work, stiffened by other materials.

The plate should be thick enough to afford the necessary support to the teeth; but not so thick as to be clumsy or inconvenient from its weight. The clasps generally require to be about one-third or one-half thicker than the plate, and sometimes double the thickness. The gold used for this purpose is sometimes prepared in the form of half-round wire; but in the majority of cases it is preferable to have it flat, as such clasps afford a firmer and more secure support to artificial teeth than those which are half round; they also occasion less inconvenience to the patient, and are productive of less injury to the teeth to which they are attached.

Artificial teeth, applied in this way, may be worn with great comfort and can be taken out and replaced at the pleasure of the person wearing them. It is important that they should be very frequently cleansed to remove the secretions of the mouth that get between the plate and gums and between the clasps and teeth, which, becoming vitiated, may irritate the soft parts and corrode the teeth and taint the breath. This precaution should on no account be neglected. Great care, therefore, should be taken to fit the clasps in such a manner as will admit of the easy removal and replacement of the piece, and also that they may not exert any undue pressure upon the teeth to which they are applied.

If the clasp, in consequence of inaccurate adjustment, strains the position of the tooth in its socket, it may excite inflammation in the alveolo-dental periosteum, and the gradual destruction of the socket will follow as a natural consequence. Also, if the clasp press too closely upon the neck of the tooth it may develop a morbid sensibility in the cementum, causing great annoyance and possibly exciting inflammation and alveolar absorption or loosening of the tooth.

Several years since Dr. Goodall obtained a patent for a method of retaining partial sets of artificial teeth by elastic or spring plates of vulcanized rubber, the utility of which, indiscriminately applied, as well as the validity of the patent, some are disposed to doubt, contending that these plates differ but little from metallic ones formerly in use, constructed in the same manner, and described as partial or stay-clasps.

This form of clasp, instead of embracing the natural tooth, simply presses against the inner surface of the contracted portion of the crown near the gum, with a force which is sufficient to keep the substitute in place.

Professor Austen's method of taking plaster impressions in partial cases was designed by him, in 1858, with special reference to obtaining an accurate copy of the inner surface of bicuspids and first molars. Accurate fitting of the vulcanite plate against one or two such teeth on each side prevents lateral motion and gives great stability to the piece. It takes the place of the vacuum cavity, with much better results; in fact, he regarded this form of stay-plate essential to every partial piece not clasped, whilst he regarded the cavity worse than useless.

The reader is referred to the chapter describing the method of retention by clasps.

ARTIFICIAL TEETH WITH SPIRAL SPRINGS.

The difference between the method of applying artificial teeth last noticed and the one now to be considered consists in the manner of confining them in the mouth. The former is applicable in cases where there are other teeth in the mouth to which clasps may be applied; the latter is designed for confining a double set; more rarely a single set or part of a set. When plates with spiral springs are used, the teeth are attached to them in the same manner as when clasps are employed, but instead of being fastened in the mouth to other teeth, they are kept in place by means of the spiral springs, lying one on each side of the artificial dentures between them and the cheeks, passing from the upper piece to the lower.

Spiral springs were formerly much used, and although various other kinds of springs have been used none seem to answer the purpose as well as these. When they are of the right size and attached in a proper manner they afford a very sure and convenient support. They exert a constant pressure upon the artificial pieces, whether the mouth is opened or closed. They do not interfere with the motions of the jaw, and, although they may at first seem awkward, a person will soon become so accustomed to them as to be almost unconscious of their presence. They are, however, liable to derangement from accident; they make the piece awkward to handle in the necessary daily cleansing; they retain the secretions offensively, and not unfrequently are a source of much irritation to the cheek.

It is, therefore, a subject of congratulation that successive improvements in the process of adapting the plate to the mouth have gradually lessened the number of cases in which spiral springs are

thought necessary. It is now rare to meet with a case in which they are absolutely essential for the permanent retention of the piece. Occasional use is made of them for the temporary retention of a piece made soon after extraction, in which the plate is designedly made more even than the irregular alveolar border, which plate cannot, of course, fit the mouth until the inequalities of the gum have yielded to the pressure of the plate.

TEETH RETAINED BY ATMOSPHERIC PRESSURE.

The method of confining artificial teeth in the mouth last described, is often inapplicable, inefficient, and troublesome, especially for the upper jaw; in such cases the atmospheric pressure, or suction method, is very valuable. It was, for a long time, thought to be applicable only to an entire upper set, because it was supposed that a plate sufficiently large to afford the necessary amount of surface for the atmosphere to act upon could not be furnished by a piece containing a smaller number of teeth. Experience, however, has proved this opinion to be incorrect. A single tooth may be mounted upon a plate presenting a surface large enough for the atmosphere to act upon for its retention in the mouth; but when only a partial upper set is required it is often more advisable to secure the piece by means of clasps. For a like reason it was thought that the narrowness of the inferior alveolar ridge would preclude the application of a plate to it upon this principle, and in this opinion the author once coincided; but he has succeeded so perfectly in confining lower pieces by this means that he now never finds it necessary to employ spiral springs for their retention.

The principle upon which this plan is founded may be simply illustrated by taking two small blocks of marble or glass, the flat surfaces of which accurately fit each other. If, now, the air between them is replaced by water, the atmospheric pressure upon their external surfaces will enable a person to raise the under block by lifting the upper. Upon the same principle a gold plate, or any other substance impervious to the atmosphere and perfectly adapted to the gums, may be made to adhere to them.

The firmness of the adhesion of the plate or base to the gums depends on the accuracy of its adaptation. If this is perfect it will adhere with great tenacity, but if the plate is badly fitted or becomes warped in soldering on the teeth, its retention will often be attended with difficulty. It is also important that the teeth should be so arranged and antagonized that they shall strike those in the other jaw on both sides at the same instant. This is a matter that should never be overlooked, for if they meet on one side before they come

together on the other, the part of the plate or base not pressed upon may be detached, and, by admitting the air between it and the gums, cause it to drop.

Since in the act of mastication pressure is made on one side with no counter-pressure on the other, this inequality will not necessarily detach a well-made piece. But when the upper molars are set so far from the median line of the mouth that the line of pressure falls outside the alveolar ridge, it is difficult to retain the best-fitting piece in place during mastication.

It is also of the utmost importance that, by proper selection of the impression material and judicious management of subsequent processes, the plate should bear upon the ridge more than upon the palate. In doing this, however, no more space should be left than a few days' wear will obliterate, giving absolute contact over the entire surface. For there is no kind of space, cavity, or chamber which gives so complete a vacuum as contact, or which secures such permanently useful adhesion of the plate.

The application of artificial teeth on this principle has been practiced for a long time. Its practicability was first discovered by the late Mr. James Gardette, of Philadelphia. But the plates formerly used were ivory instead of gold, and could seldom be fitted with sufficient accuracy to the mouth to exclude the air; so that, in fact, it could hardly be said that they were retained by its pressure; except in that class of cases in which the mouth, by virtue of a soft membrane, has power to adapt itself to the plate. Unless fitted in the most perfect manner, the piece is constantly liable to drop; and the amount of substance necessary to leave in an ivory substitute renders it so awkward and clumsy that a set of teeth mounted upon a base of this material can seldom be worn with much comfort or satisfaction.

The firmness with which teeth applied upon this principle can be made to adhere to the gums and the facility with which they can be removed and replaced renders them, in many respects, more desirable than those fixed in the mouth with clasps. But unless judgment and proper skill are exercised in the construction of the work, a total failure may be expected, or, at least, the piece will never be worn with satisfaction and advantage.

There were few writers, at the time of the publication of the first edition of this work, who had even adverted to this mode of applying artificial teeth. Drs. L. S. Parmly and Koecker had each bestowed on it a passing notice. The former, in alluding to the subject, thus remarks: "Where the teeth are mostly gone in both or in either of the jaws, the method is to form an artificial set by

first taking a mould of the risings and depressions of every point along the surface of the jaws, and then making a corresponding artificial socket for the whole. If this be accurately fitted it will, in most cases, retain itself sufficiently firm by its adhesion to the gums, for every purpose of speech and mastication."

Modifications of the atmospheric pressure principle have been made since 1845, by constructing the plate with an air-chamber or cavity, so that when the air is exhausted from between it and the parts against which it is placed, a more or less complete vacuum is formed, causing it to adhere when first introduced with greater tenacity to the gums than a base fitted without such cavity. This modification might be termed an improvement were it not that its introduction has become so unnecessarily general, has so often induced a diseased condition of the mucous membrane, and has led to a slovenly, careless method of swaging and fitting plates. For these and some other reasons, Professor Austen regarded its introduction as a positive detriment, at the same time that he acknowledged its occasional utility. He argued that theory and practice alike condemn the use of a cavity for the permanent retention of any piece, and suggests for its temporary retention, whilst the work is going through its stage of adaptation, some other plan than this permanent disfigurement. The so-called vacuum cavity can, at best, be only partially a vacuum, hence cannot give the amount of atmospheric pressure that perfect contact will. So long as it acts in the retention of a piece it necessarily draws the yielding membrane into the space, and must ultimately fill it. When this is done, the piece is evidently retained by the "vacuum of contact." If, in any case, the mouth does not show the size and depth of the cavity imprinted on the palate, it proves that the vacuum force is not exerted, and that the piece is retained by contact of the parts around the cavity. In these cases, of constant occurrence, the cavity diminishes the adhesion of the plate, and can only be of service where it helps to remove pressure from a hard palate. But as this can be done in a better way, it is no argument in favor of the cavity.

The only cases in which this chamber is permanently useful are very flat mouths with scarcely any perceptible ridge. A sharply defined cavity, varying in depth from one-half to one line, according to the softness of the membrane, when filled by this membrane, tends to prevent any lateral motion of the piece, so troublesome in such cases.

Partial pieces not retained by clasps, or the lateral pressure of stays, or their closeness of adaptation, are never permanently im-

proved by the cavity. Even in pieces made soon after extraction (so unfortunately named temporary sets), the temporary action of the cavity is of very questionable utility (see Chapter XIII).

CHAPTER IV.

PREPARATORY TREATMENT OF THE MOUTH.

THE condition of the mouth is not sufficiently regarded in the application of artificial teeth, and to the neglect of this the evil effects that so often result from their use are frequently attributable. An artificial appliance, no matter how correct it may be in its construction and in the mode of its application, cannot be worn with impunity in a diseased mouth. Of this fact every day's experience furnishes the most abundant proof. Yet there are men in the profession so utterly regardless of their own reputation and of the consequences to their patients as wholly to disregard the condition of the mouth, and are in the constant habit of applying artificial teeth upon diseased roots and gums, or before the curative process after the extraction of the natural teeth is half completed.

The dentist, it is true, may not always be to blame for omitting to employ the means necessary for the restoration of the mouth to health. The fault is often with the patient. There are many who, after being fully informed of the evil effects which must of necessity result from such injudicious practice, still insist on its adoption. But the dentist, in such cases, does wrong to yield his better informed judgment to the caprice or timidity of his patient, knowing, as he should, the lasting pernicious consequences that must result from doing so. If he is not permitted to carry out such plan of treatment as may be necessary to put the mouth of his patient in a healthy condition previously to the application of artificial teeth, he should refuse to render his services. No professional man can be permitted to plead in excuse for any professional error that his patient over-persuaded him. No community will accept such excuse, or hold the patient in any degree responsible for the consequences.

Dr. Koecker, in treating upon this subject, says: "There is, perhaps, not one case in a hundred requiring artificial teeth in which the other teeth are not more or less diseased, and the gums and alveoli, also, either primarily or secondarily affected. The mechani-

cal and chemical bearing of the artificial teeth, even if well contrived and inserted upon such diseased structures, naturally becomes an additional aggravating cause of disease in parts already in a sufficient state of excitement; if, however, they are not well constructed, and are inserted with undue means or force, or held by too great or undue pressure, or by ligatures or other pernicious means for their attachment, the morbid effects are still more aggravated, and a general state of inflammation in the gums and sockets, and particularly in the periosteum, very rapidly follows. The patient, moreover, finds it impossible to preserve the cleanliness of his mouth; and his natural teeth, as well as the artificial apparatus, in combination with the diseases of the structures, become a source of pain and trouble; and the whole mouth is rendered highly offensive and disgusting to the patient himself as well as to others." *

The first thing, then, claiming the attention of the dentist, when applied to for artificial teeth, is to ascertain the condition of the gums and of such teeth as may be remaining in the mouth. If either or both are diseased, he should at once institute such treatment as the circumstance of the case may indicate; but as this has been described in a preceding chapter, the reader is referred for directions upon the subject to what is there said. Without, however, repeating previous medical and surgical directions, a few brief hints are necessary as to what teeth or roots should be extracted and what allowed to remain in preparation for a dental plate.

All incurably diseased roots or teeth should be removed, also all roots of molars in either jaw, and all roots, without exception, in the lower jaw. Firm and healthy roots of bicuspids may sometimes be retained, the plate coming to the inner edge of such root and the artificial crown resting upon it. It is desirable to retain upper incisors or canine roots, unless an adjacent tooth has lost its root or is incurably diseased. These cases of retention of roots presuppose the presence of other teeth; for when only roots remain in the jaw they must be extracted. Also, they must be removed, however sound, if they are sources of irritation in, or are partially covered with, mucous membrane.

Very loose teeth, although not carious, should be extracted; but teeth in which caries or abscess can be permanently cured rank as sound teeth. All sound teeth must be retained, if there are more than four in either jaw, unless some peculiar circumstances justify their removal. Cases of this kind are so varying that no fixed rule can be laid down; but a few cases may be given in illustration of the principles that should guide the practitioner.

* Koecker's Essay on Artificial Teeth, pp. 27, 28.

Two, three, or four molars alone remaining should be retained, especially if they have antagonists. They do not complicate the construction of the piece or interfere with its utility; but they should not be clasped, since the whole weight being in front of the clasp brings too much strain on the teeth. Two, three, or four incisors alone remaining cannot be extracted except by request of the patient; for although they complicate the construction, and may interfere somewhat with the strength and beauty of the work, they may be too valuable to justify their loss. The cuspids must be retained, if sound, not displaced, and free from alveolar absorption, although their retention may greatly complicate the work.

In cases of protrusion of the lower jaw, it may be advisable to extract the five front teeth in either jaw, where these are the sole remaining ones, with a view to correct, in part, the protrusion of the mouth. But this cannot be done without fullest consent of the patient; even then is scarcely advisable unless these teeth are frail in texture, or their position amounts to deformity.

In all cases it should be the rule never to sacrifice a sound tooth for the purpose of replacing an artificial one, unless the benefit of the exchange is so undoubted as to be recognized by both patient and operator.

When artificial teeth are to be secured in the mouth in any other way than by pivoting upon the roots, if the patient desires but one piece, sufficient time should elapse before its insertion for the completion of those changes in the alveolar ridge that follow extraction.

It is often necessary to wait from eight to fifteen months, after the removal of the natural teeth, for the completion of these changes. Comparatively few persons, however, are willing to remain for so long a time without teeth; nor, on many accounts, is it desirable that they should. In this long interval the lips lose somewhat their natural expression, and the under jaw forgets its natural motion and inclines to project. The artificial piece or pieces feel more awkward and unmanageable than if inserted at once; they also interfere more with the articulation and motions of the tongue, which have become accustomed to the absence of the teeth.

Hence the insertion of artificial pieces may become advisable very soon after extraction—the interval varying from hours or days to weeks or months. In some of these cases the piece will have to be remodeled at short intervals; in other cases the piece, as first made, continues to be worn for many years with much comfort. It is not easy to explain these differences. Much depends upon the nature of the mucous and submucous tissues, whether hard or soft; and much also upon the manner in which the alveolar ridge changes.

It may take place rapidly, and with slight regard to the shape of the plate; in which case the patient has to use much tact in retaining the piece in place. Or it may take place slowly, following, as it is apt more or less to do, the shape of the plate; in which case it may be worn with some comfort, or even with great satisfaction, for a long time.

A plate made immediately after extraction should not fit the ridge exactly; but allowance should be made for the rapid absorption of the prominent edges of the alveoli. Some practitioners advise the anticipation of this process by "paring down" the alveolar ridge. This "bold surgery" has its advantages and its advocates. The operators say it does not hurt much; but the testimony of the patient on this point is more trustworthy.

The almost universal use of the term "temporary," applied to a piece made within six months after extraction of the teeth, is much to be regretted. It tempts the dentist to a slovenly style of half-made work, good enough, in his estimation, for what is so soon to be replaced. It also renders the patient reluctant to make proper compensation for the time and skill employed. Both feelings react, until it has become a notorious fact that much low-priced work passes from the hands of skillful mechanicians which they would indignantly disown as specimens of their workmanship.

Yet they are specimens which a community is right in judging by. It is unfortunate for dentistry that so many, using their best efforts, accomplish poor results. But it is infinitely more damaging to its character that a skilled operator should, under any pretext, permit himself to be false to the trust reposed in his professional capacity. A chain is judged by its weakest link, and a workman's reputation turns on his poorest work. This seemingly harsh verdict is a just one, because necessary to keep the majority of men to the full measure of their ability.

Let the work be done as if it never was to be done again. Many circumstances may prevent the return of the patient; it also frequently happens that no necessity is felt, especially if properly done, for the renewal of the piece. If the patient understands that the necessity of renewal is not in the work itself, but arises from unavoidable changes in the mouth, there will be no difficulty about proper compensation. But if the absurd practice of half-price at one time for what receives full price at another must be maintained, then by all means let the second piece be the half-paid one.

The point, however, involves far higher questions than the one of fees. No dentist who properly respects himself or his profession

will, either on the score of insufficient pay or temporary use, permit himself to issue two grades of work. Like Pharaoh's lean kine, the low grade will, slowly, perhaps, but inevitably, destroy the high grade. The only safe rule is "excelsior" in every case.

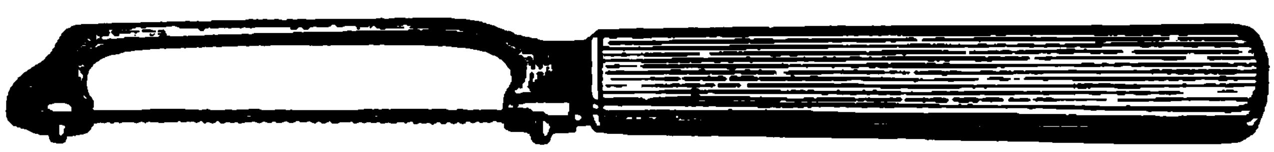
CHAPTER V.

CROWN AND BRIDGE-WORK.

PREVIOUS to the preparation of a natural root for the reception of an artificial crown, the remaining teeth and gums, if diseased, should be restored to health. This done, such portion of the crown as may not have been previously destroyed by caries should be removed.

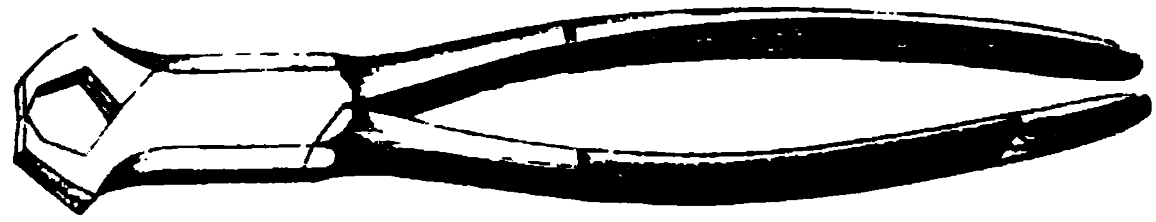
The usual method of performing this part of the operation, when much of the crown remains, consists in cutting the tooth about three-fourths off with a file, a very fine saw (Fig. 548), or corundum

FIG. 548.



disk, and then removing it with a pair of excising forceps. But the forceps should not be applied until the tooth has been cut with a file on every side, nearly to the pulp cavity, and even then great care is necessary to prevent jarring, or otherwise injuring the root.

FIG. 549.



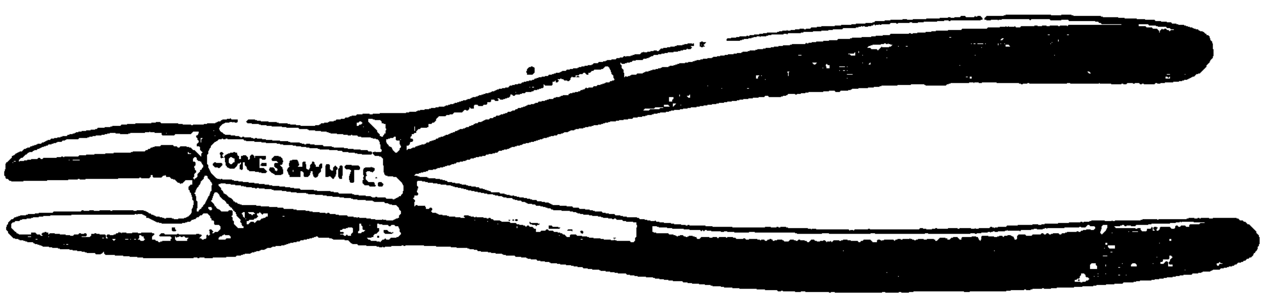
When too large a portion of the crown is clipped off suddenly with excising forceps, the concussion is often so great as to excite inflammation in the socket of the tooth, and sometimes to fracture the root.

When excising forceps are used in this way, they should be strong, so as not to spring under the pressure of the hand, with cutting edges about an eighth of an inch wide (Fig. 549). But we should prefer, where a large part of the crown is left, to remove it entirely with the fine saw, or separating file, or corundum disk. Where

there is only a jagged remnant of the crown left, it should be gradually cut away by a pair of cutting forceps made as light as possible, with a spring between the blades of the handles to keep them apart. The cutting edges may be shaped as in the ordinary excising forceps (Fig. 549), or somewhat like the beaks of Parmly's duck-bill root forceps, represented in Fig. 550.

After the removal of the remaining portion of the crown, the pulp, if still alive, should be immediately destroyed by introducing a silver or untempered steel wire, or barbed broach, up to the extremity of the root by giving it at the same time a quick rotary motion. It is important that the instrument used for this purpose should be soft and yielding, otherwise any sudden motion of the

FIG. 550.



patient might break it off in the tooth. Its extremity should also be barbed or bent so as to entangle and drag out the pulp when withdrawn.

The pulp having been destroyed, the remainder of the operation will be painless. The root may now be filed or ground off a little above the free edge of the gum with an oval or half-round file, or a corundum wheel with a round edge. The file should be new and sharp, so as to cut rapidly, but not too coarse, lest it jar the root too much. It must be kept cold and clean by frequently dipping in water; also the corundum wheel. Fig. 551 represents pivot files and wheels. The exposed extremity of the root after having been thus filed should present a slightly arched appearance, corresponding with the festooned shape of the anterior margin of the gum.

After having completed this part of the operation, the natural canal in the root should be slightly enlarged with a burr-drill, or a broach prepared for the purpose. A slightly projecting point on the end of the drill will serve, by entering the canal, to guide the instrument, which must be held steadily in one direction. The canal thus formed in the root for the pivot should never exceed the sixteenth part of an inch or a line in diameter, or a quarter or three-eighths of an inch in length.

If, from any peculiar constitutional susceptibility, there is reason to apprehend inflammation of the alveolo-dental membrane, the insertion of the tooth may be delayed a few days for the subsidence

Fig. 551.

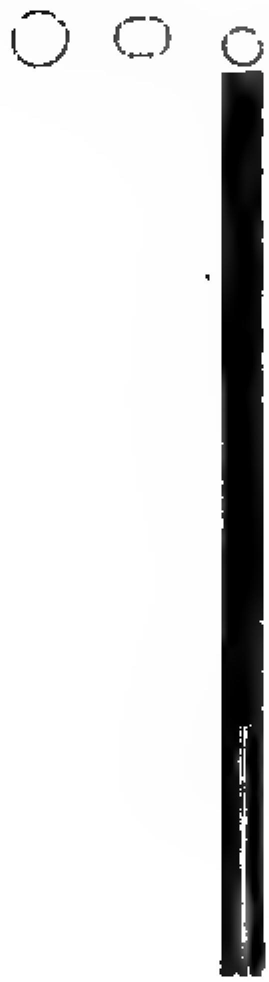


Fig. 552.

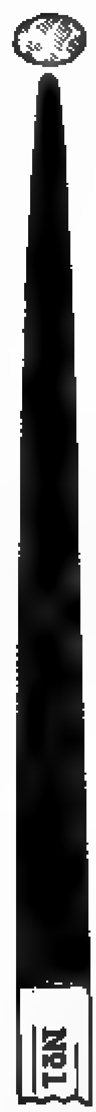
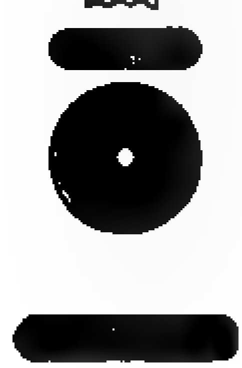


Fig. 553.



of any irritation which may have been occasioned by the preparation of the root. It will be prudent to do this in all cases, although it rarely happens that the operation is followed by any unpleasant effects unless the root has previously lost its vitality by the spontaneous disorganization of the nervous pulp. In this case, an outlet is sometimes made by cutting a groove on the side of the pivot, or in some other way, for the escape of any matter which may form at the apex of the root; but it is far better in such cases to extract the root, unless the discharge can be permanently arrested. Dr. Maynard believes that the irritation in most cases arises from an accumulation of acrid matter in the upper part of the root; by removing which, and by filling the natural canal above the terminus of the pivot up to the extremity, it may generally be prevented. This should always be done before deciding to extract the root.

After having prepared the root, an artificial crown of the right shape, color and size is accurately fitted to it. It should touch every part of the filed extremity of the root, and be made to rest firmly upon it, to give security of support, and to exclude food and other substances which, by their decay, will give rise to unpleasant odors. Care must also be used to have the tooth placed in exact line with the other teeth, not inclining unnaturally to either side, and not so long as to touch the lower teeth when the mouth is closed. To fit the crown accurately is often a tedious process and wearies the patient. To avoid this an impression of the space may be taken and the crown adapted to the model, which should be hardened by varnish or soluble glass.

The canal in the root and that in the artificial crown should be directly opposite to each other. When the crown of a natural tooth is used it can be adapted to the root by the use of the file; the proper place for the pivot is indicated by the pulp cavity, but in porcelain teeth the hole is not always in the centre.

In selecting a suitable artificial pivot tooth, it is often difficult to find the several conditions of length, width, color, and position of pivot hole just as required. The last two cannot be changed, but the first two may often be modified by the corundum wheel. If the color cannot be exactly matched, it is perhaps better to select one a shade darker, rather than lighter.

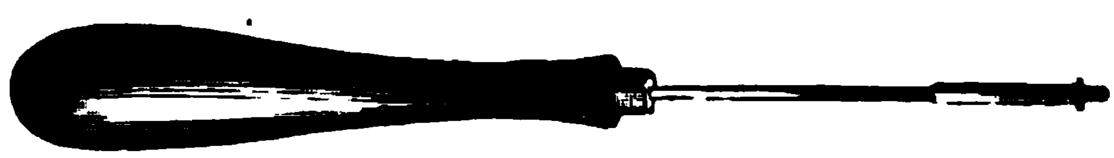
For grinding the edges, sides, or base of the tooth, any of the hand or office foot-lathes in use will answer very well (Figs. 552 and 553)

The artificial crown may be secured to the root by means of a pivot made of wood or metal; when the latter is employed, gold, platinum, or platinum and iridium is to be preferred, inasmuch as silver or any baser metal is liable to be oxidized by the fluids of the mouth.

If wood is used, it should be of the best quality of well-seasoned, young, white hickory or locust, as these possess greater strength and hardness than any others that can be used for the purpose. After being reduced nearly to the size of the canal in the artificial tooth, it should be forced through a smooth hole of the proper size, in a piece of ivory, bone, steel, or some other hard substance, for the purpose of compressing its fibres as closely together as possible. Thus prepared, one end is forced into the cavity in the artificial crown, and the projecting part cut off about a quarter or three-eighths of an inch from the tooth, according to the depth of the canal. If the canals in crown and root are equal in size the pivot is ready to be pressed into place, which should be done with the thumb and forefinger if the pivot is made of compressed wood. But if the canals differ in size, the wood must be compressed to the size of the larger and then trimmed down to fit the smaller. The end thus trimmed should require more force for its introduction, since the compressed wood swells most from moisture. The part of the pivot going into the root, if made of compressed wood, should never be so large as to

FIG. 554.

FIG. 555.

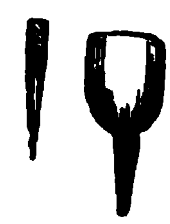


require any other pressure than that which can be applied with the thumb and forefinger, as the swelling of the wood will soon render it sufficiently tight to hold it firmly in its place; and if too tight, the subsequent swelling will split the root. The practice of driving a pivot up with a hammer or by very strong pressure, as is often done, is a bad one. It is apt to cause inflammation and suppuration of the soft tissues about the apex of the root. The utmost force admissible, and this only in the case of uncompressed pivot wood, is somewhat more than can be made with the thumb and finger, applied by means of a small piece of wood notched at the end to receive the cutting edge of the tooth.

It is important that the pivot should exactly equal the depth of the canal. If too long, the crown will not go up to its place; if too short, there will be either an unnecessary weakening of the root or the crown will be insecure. A small piece of smooth wire or knitting needle, with a sliding collar of wood or gutta-percha, forms a simple instrument for measuring the depth of the canal in the root. Fig. 555 represents a convenient gauge for this purpose. A porcelain tooth with a wooden pivot presents, before insertion, the appearance represented in Fig. 554.

When a metallic pivot is used the end going into the artificial crown may be fastened in either of the following ways: First, by cutting a screw on it, either with a file or passing it through a screw-plate; the cavity in the crown should next be filled with wooden tube, and the pivot then screwed into it; or the pivot may be first screwed into a small block of pivot wood, and the wood then trimmed to fit the crown. Second, by filling the pivot hole with pulverized borax, moistened with water, inserting the end of the pivot into it, which should be large enough to fill the cavity, placing several small pieces of solder around it, and fusing them with a blowpipe. The solder, adapting itself, when in a state of fusion, to the rough walls of the cavity in the crown of the tooth, will prevent the pivot from loosening or coming out; or the metallic pivot may be attached to the porcelain crown by "firing" with jeweler's enamel; shellac is also used for fastening the pivot in the crown, in the form of powder, the pivot being warmed to soften it; also the zinc filling materials. The projecting part of the pivot should be about half an inch in length. By some it is made square and pointed, as in the figure; but the best form is a polished cylinder. The latter resists more firmly any downward traction, while the curve of the face of the root will prevent the pivot turning on its axis. The cavity in the root, which requires to be deeper for a metallic than for a wood pivot, may be filled with wood, having a small hole through the centre. Into this the end of the pivot is introduced and forced up, until the tooth and root come firmly together. The appearance of a porcelain tooth prepared with a metallic pivot for insertion in this manner is shown in Fig. 556. At the present time wood is but seldom employed for pivots.

FIG. 556.



In some cases when a metallic pivot is used, a plate tooth may be considered preferable to one made expressly for pivoting. The manner of attaching a pivot to the former is as follows: The root is first prepared, after which an impression is taken; from this a plaster model is made, and from the latter metallic dies. This done, a piece of gold plate, large enough to cover the root, should be swaged up between the dies; a plate tooth of the proper size, shape and color, is then fitted to the root, backed with gold, and soldered to the plate. To the upper or convex surface of this last, and immediately beneath the canal in the root, a gold pivot is attached. The position and direction of this pivot is thus secured. Press the plate, covered with a very thin film of wax, against the root; at the point opposite the canal, thus marked on the plate, drill a hole; through this pass a gold pivot into the canal;

FIG. 557.

press softened sealing wax around the part of the pivot (made purposely too long) below the plate, and remove the fixture from the mouth. Invest the upper part of the pin and plate in plaster (keeping it, by means of a minute collar of wax out of the hole through which the pin passes), remove the sealing wax, cut off the pin even with the plate, and solder. A front and side view of a tooth thus prepared is shown in Fig. 557.

Porcelain crowns are now made with metallic pivots or pins baked in position. Figs. 558, 559, 560, and 561 represent Dr. E. Parmly Brown's Tooth-Crowns.

Fig. 558 is a lateral view of a porcelain crown, with a platino-iridium pin baked in position. The pin has great strength at the neck of the tooth, where the strain is greatest, the porcelain of the tooth extending up on the pin to increase the strength.

Fig. 558.

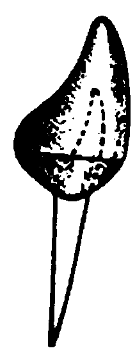


Fig. 559.

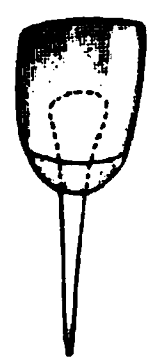


Fig. 560.

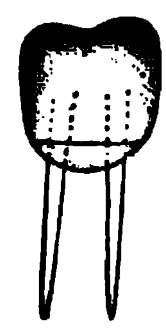


Fig. 561.

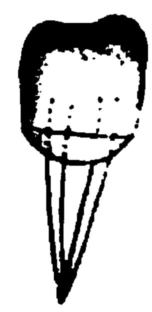


Fig. 559 is a front view of the same crown, showing by dotted lines the form which the metal occupies in the crown to increase the strength of the attachment and prevent the pin from approaching the surface in thin teeth.

Fig. 560 is a view of the two-pin bicuspid crown, which affords a pin for each root of a two-rooted bicuspid.

Fig. 561 is a view of a bicuspid crown with the two pins pressed together, making a single pin for one root.

The double pin in the bicuspid crown prevents the loosening of these teeth by the rotary movements of mastication, which by means of the two cusps exert such leverage as to turn and break down the ordinary crown where only one pin is used.

The roots are ground concave to fit the crowns with corundum points or a Willard countersink burr, and the close joints are made well under the gum, setting the pins with oxyphosphate cement.

A pivot, consisting of gold encased in a thin layer of wood, has also been employed. It is prepared in the following manner: The gold is first made into wire of proper size, and passed through a screw plate; a hole is then drilled lengthwise into a piece of well-seasoned hickory, as far as required for the length of the pivot, and

a thread cut with the corresponding screw tap; into this the wire is screwed, and then cut off close to the wood, which is reduced with a file or knife nearly to the size of the orifice in the artificial crown, and then condensed by passing through a pivot draw plate. Subsequent manipulations are the same as given for the simple wooden pivot; from which it differs in being stronger, also in permitting a slight bend in the pivot in case the canals in root and crown are not in precisely the same direction. The wood prevents the gold from enlarging the cavity of the root or from being worn by friction in the pivot hole of the artificial tooth; and at the same time, by the swelling of this encasement, the pivot is firmly retained in both.

Another method is to screw a gold cylinder into the root, and fill around it with gold where any space exists, the lower part of the canal being enlarged and undercut for the purpose. A disk of plate gold or platinum is then accurately fitted to the exposed surface of the root, to which a split pivot and the plain plate tooth are soldered.

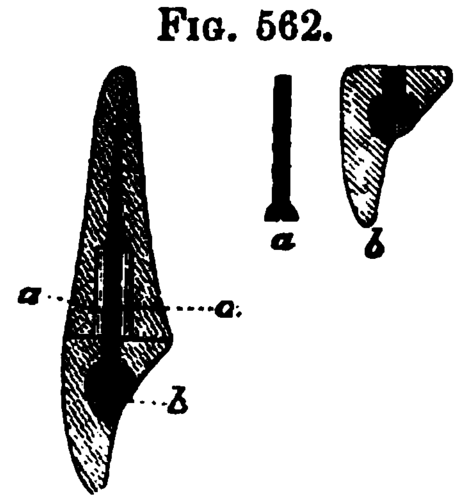
Another method is to fill the root solid with gold, and to build the gold over the exposed surface. A hole for the reception of the pivot is then drilled in the centre of the gold filling; amalgam may be substituted for the gold.

In 1840 Henry Lawrence obtained a patent for a pivot tooth, which consisted of an ordinary pivot crown, with a hole entirely through it, ending in a countersink, to accommodate the head of a screw of gold or other suitable metal, by which the crown was secured to the root.

A method of pivoting suggested by Dr. E. W. Foster combines the screw of Woofendale with the wood casing in the root, the novel features being a rounded head to the screw and a rounded cavity in the crown for its reception. Fig. 562 shows the crown screw and method.

The pulp canal is enlarged by the drill sufficiently to accommodate a compressed hickory pivot, the canal above it being filled with gold. The wood pivot is cut off flush with the exposed surface of the root, and the crown fitted and held in position while a drill is passed through the hole in the crown, and an opening made through the wood pivot in the root. A steel screw then attaches the crown to the root, between which a few layers of gold foil are placed. Gold is then packed in the hole in the crown over the screw head. Gutta-percha or one of the zinc preparations may be used between the crown and root, instead of the layers of gold foil.

FIG. 562.



As a general rule, not more than two roots should be prepared at one sitting, though sometimes four, or even six, may be prepared without incurring any risk. When a tooth is attached by any of the ordinary modes of pivoting, the walls of the canal in the root are, of necessity, exposed to the action of the fluids of the mouth, and, consequently, are gradually softened and broken down; so that, in the course of a few years, a larger pivot will be required, and this, too, will have to be again replaced with one still larger, until, finally, the root is destroyed. This destructive process proceeds more rapidly in some cases than in others, accordingly as the root is hard or soft, and as the secretions of the mouth are in a healthy or vitiated condition. This may be prevented by introducing a gold cylinder for the reception of the pivot. This protects the walls of the canal against the action of corrosive agents, and a root thus prepared will support an artificial crown more than twice as long as when prepared in the ordinary way. The operation, however, is more tedious and expensive, and only the larger roots will permit the enlarged size of canal required.

For the preparation of a tooth in this manner, the following is the method of procedure: First, the crown of the natural tooth is removed, the pulp, if alive, destroyed, and the canal in the root enlarged as before directed. Secondly, a screw-tap is introduced for the purpose of cutting a screw on its inner walls. Thirdly, a corresponding screw-thread is cut on a piece of hollow gold wire, during which process the gold tube is slipped over a steel mandrel, to prevent compression. This done, it may be screwed into the root about a quarter of an inch; the mandrel is then withdrawn, and the lower or protruding extremity dressed off even with the root, with a very fine file. Fourthly, an artificial tooth is selected, of the right size, shape and color, and fitted to the root; after which a gold pivot is fixed in it in the manner before described, corresponding in size and length to the gold tube in the root. Having proceeded thus far, the operation is completed by applying the tooth to the root, but little pressure being required to force up the pivot.

The stability of a tooth secured in this manner, if the pivot be of the proper size, is as great when first inserted as one prepared by any of the other methods, and it may be removed, cleansed, and replaced at the pleasure of the patient. But metal against metal inevitably wears, and rapidly so, if removed from time to time. Hence many prefer the wooden pivot with a wire run through its centre. When the walls of the canal are so much enlarged by decay as to have formed a conical-shaped cavity in the lower extremity of the root, the upper end only of the cylindrical screw will take effect.

In this case the space between the lower extremity and the walls of the root must be thoroughly filled with gold before the wire on the inside is withdrawn; after which the tube and extruding portions of the gold are filed off even with the root and polished before the artificial tooth is applied.

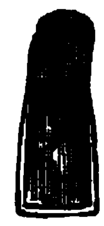
The hollow wire is made by partly folding a narrow, evenly-cut strip of gold around a steel mandrel (a knitting-needle makes an excellent one), and passing through a draw plate; withdraw the mandrel and solder the seam; then replace the mandrel and complete the drawing until the proper thickness is given. If too thin, it will not hold the screw thread; if too thick, it will either make the canal too small or require too large an opening in the root. Hollow wire may be procured of the proper size at less expense of time and money than it can be made by a dentist. It is known by jewelers as *joint wire*, because used for the hinges of breastpins, etc.; but such wire is rarely over twelve carats fine.

It sometimes happens that the natural root, instead of occupying its proper position in the jaw, runs very obliquely; so that if the pivot connecting the artificial tooth to it be straight, the latter will either overlap the adjoining teeth or else project outward or inward. To obviate this an angle should be given to the pivot immediately at the point of junction between the tooth and root. If this obliquity be slight, the wooden pivot, stiffened with wire, can easily be bent to suit; but in cases of greater obliquity a solid gold pin will be required.

Some cases are met with presenting a more formidable difficulty; as, for example, when the root is situated behind the circle of the other teeth. In a case of this sort a different kind of tooth and an entirely different course of procedure are necessary. After having prepared the root, an impression of the parts is taken in wax, from which a plaster model is obtained, and from this two metallic dies. With these a gold plate is to be swaged, extending backward so as to cover the root, and forward to form a line with the outer circle of the teeth. To the posterior part of the plate covering the root, and directly beneath the cavity in it, a gold pivot, about three-eighths of an inch long, is soldered, and to the anterior part of it a plate tooth of the right size, shape and shade is attached. A piece of hollow wood, or a hollow gold screw as before described, is now introduced into the root, and into this the gold pivot is inserted. A right superior central incisor mounted on a plate with a pivot, for insertion in the manner here described, is represented in Figs. 563 and 564.

Fig. 563.

Fig. 564.



A method of inserting an artificial tooth on a metallic pivot is described by the late Dr. James B. Bean in Vol. III, 1869–70, of the *American Journal of Dental Science:* "Having filed or sawed off the remaining portions of the crown, the exposed surface of the root is smoothly filed to within one-half or one-fourth of a line below the margin of the gum, giving it a slight concave appearance, so as to accommodate the neck of the *plate tooth* which is to rest against it. It is well at this stage of the operation to stop the canal loosely with a pellet of cotton or floss silk saturated with spirits of camphor, and to dismiss the patient for two or three days. If no inflammation be present, the canal may then be cleaned out and carefully filled with gold foil from the apex to within four or five lines of the orifice.

"The remaining portion of the canal not filled should now be enlarged to about one line in diameter, if the size of the root will admit of it, down to the gold filling, making the bottom smooth and solid and the sides parallel. The orifice, to the depth of nearly a line, is again enlarged with a burr-drill to about two lines in diameter, and a small groove or undercut is formed around the margin for the retention of the gold filling subsequently to be introduced around the tube.

"Hollow gold, jeweler's wire, or simple gold tubes made of gold plate may be employed. If the latter is chosen, it is formed by bending a piece of ordinary gold plate around a wire, so as to form a cylinder sufficiently large to fit the smaller portion of the canal prepared for it; then solder with the finest gold solder. A piece of the tube half an inch in length should be cemented with shellac into a hole bored through a piece of wood half an inch in thickness, to serve for a handle; the interior is then carefully dressed out with a jeweler's broach which has a slight taper, making it smooth and regular within. A solid gold wire pivot is now carefully filed and fitted by grinding it with fine emery and water, making a 'ground joint,' whereby the pivot is firmly held when in place. Any portion of the wire that may project beyond the smaller end of the tube should be cut evenly off, while at the larger end it should project at least one-fourth of an inch.

"The tube must be taken out of the cement and a piece of plate soldered to the smaller end, forming a *bottom*. An easier flowing solder should be used for this, so as not to disturb the first. This tube thus formed, after being cleansed in acid and smoothly filed, is ready to be inserted into the root.

"Some have proposed to cut a screw on the tube, whereby it is firmly secured in its place, and to fill then around with gold. But

the most convenient way is to cut a number of barbs with a sharp knife, on the outside, looking toward the open end; this retains the gold in place nearly or quite as well as the screw. Being made so as to enter the root rather loosely, several folds of gold foil are wrapped around it, and after carefully drying the parts with bibulous paper—the pivot being in its place in the tube—the whole is forced to the bottom of the cavity and the loose portions of foil removed.

"Having previously prepared some cohesive foil, the space around the tube is perfectly filled with gold. The gold pivot is now removed and the tube carefully sawed or filed off nearly level with the end of the root, and the surface of the gold and the root well polished.

"Thus far we have the root preserved with a good filling, and a gold tube firmly secured in it containing an accurately fitting gold pivot.

"The next operation is to attach a suitable tooth to the pivot, and for this purpose a plain plate tooth is selected that will be suitable in size, shape, and color. This tooth should be so ground and fitted to the anterior edge of the root that the free margin of the gums will cover the point of union. Then, after soldering a strong backing to the tooth, it is fitted to its position, with the gold pivot in place, on which has been soldered a small shoulder or ring of plate, and the projecting portion of the wire cut off. This shoulder is to be made in the form of a disk, cut out of gold plate, larger than the diameter of the pivot, then perforated with a hole just large enough to admit the pivot up to the point, a little less than the depth of the tube. Being retained at this point, it is made to fit closely down on the root; the whole is then carefully withdrawn and bedded up to the ring in plaster and asbestos, thoroughly dried, the wax removed, and the piece soldered with fine solder. If the ring is loose, it must be kept in place by wax or plaster in the act of withdrawing it from the tube. The pivot is again tried in the mouth and, if satisfactory, the projecting portion is cut off, smoothly filed, and the tooth attached to it with shellac; then try in the mouth, and alter its position if necessary. If the pivot does not fit too tightly, the whole can be withdrawn together, carefully invested in plaster and asbestos, and strongly soldered. The piece is now finished up, reducing the shoulder around the pivot to less than half a line in breadth; a large plate covering the end of the root has no advantage, and would only form a lodgment for food and the secretions of the mouth, inducing decomposition and the destruction of the root.

"If the pivot is not retained sufficiently firm in the tube, it may be

wrapped with a few fibres of floss silk or cotton, and when forced into its place with a slight rotary motion it will remain quite firm, and can be used with great satisfaction. If the adjustments have been properly made, the shoulder or flange will fit closely on the edge of the tube, the neck of the tooth resting on the beveled edge made for it, thereby preventing the tooth from turning on its axis. Proper care and cleanliness, removing the tooth at least three times a week, will enable such a piece to be used with satisfaction for many years."

FIG. 565.

Fig. 565 represents an antero-posterior section of a superior central incisor root pivoted in the manner above described. *a*, dentine of root; *b*, porcelain tooth; *c*, pivot surrounded by the tube; *d*, backing, which is soldered to the tooth and to the pivot; *e*, filling between the end of tube and apex of the root; *f*, filling around the tube by which it is retained in place; *g*, flange resting on the edge of the tube; *h*, junction of the tooth and root, concealed by the margin of gum.

Another method for inserting an artificial crown on a metallic pivot is that of Dr. T. J. Thomas, by which the end of the root is protected from the action of deleterious agents and a firm support given to the tooth. It is thus described by Professor Gorgas:—

"Prepare the tooth as for an ordinary wooden pivot; then select a *plate tooth* of the proper size, shape and shade, and fit it by grinding accurately to the prepared root.

"After this is done, enlarge the pulp canal by reaming it out as large as the root will permit; that is, make a conical-shaped cavity in the exposed surface of the root, allowing the margin of this cavity to be quite near to the periphery of the root, with slight undercuts or retaining points on the anterior and posterior walls.

"After this cavity is prepared, and that portion of the pulp canal beyond it filled to the apex of the root with gold, make a square metallic pivot of twenty-carat gold alloyed with platinum, in the proportion of five parts of gold to one of platinum. This pivot is made in two parts, which are soldered together at the base of the artificial crown and slightly wedge-shaped. After the pivot is prepared, a thin piece of platinum plate is bent around it, thus forming a square cylinder into which the pivot perfectly fits. The pivot is then carefully drawn out of the square cylinder, and the edges of this cylinder soldered with pure gold. The pivot is again inserted, and the excess of solder and any rough edges which may be found in the cylinder filed off.

"After this is done, the cavity in the root is carefully dried and protected from moisture, and the square cylinder, with the pivot inside of it, is placed in the centre of this cavity, which is filled around it with gold in as careful and perfect a manner as any crown cavity. The gold is allowed to overlap the margin of the cavity, so as to perfectly protect all of the exposed—or what, in the ordinary method, would be the exposed—surface of the root.

"The gold filling, besides protecting the root, retains the square cylinder in the centre of it. In placing the cylinder in the root with the pivot in it, preparatory to inserting the gold filling around it, the split in the pivot should range directly back from the labial to the palatine surfaces, and not transversely. The pivot, after the filling is inserted, is drawn out of the cylinder, which remains firmly fixed in the root, and that part of the cylinder which projects beyond the gold is filed down to a level with the surface of the filling. An impression of this surface is then taken with wax or gutta-percha, and die and counter die made of fusible metal, by means of which a disk of platinum plate is swaged to fit accurately the concave surface of the gold filling in the root.

"When this is done, the convex surface of the disk is thinly covered with wax, and the disk placed in its proper position over the gold filling in the root, and slightly pressed on it, in order to obtain an impression of the square orifice of the cylinder, by which a hole corresponding in shape and position may be cut in the disk. The outer end of the pivot is then inserted in the square hole made in the disk, secured by means of wax, and the whole returned to the root (with pivot in the cylinder), in order to make certain that the pivot is in its proper position; then it is carefully removed and secured by an investment of plaster and asbestos, that the pivot may be soldered to the disk.

"The projecting portion of the pivot above is filed down to a level with the concave surface of the disk, and the disk and pivot returned to the cylinder in the root, when the plate tooth is placed in position and secured to the disk by means of wax.

"This done, the pivot, disk, and the plate tooth are carefully removed and invested in plaster and asbestos, in order that a backing of gold may be made, and the tooth soldered to it and the disk. The tooth is now ready to be inserted, and by slightly separating the two parts which form the pivot, at its apex or free extremity, it will tightly fit the cylinder, the two halves acting as springs, and pressing against the walls of the square cylinder inserted in the root."

The late Dr. M. H. Webb suggested several methods of pivoting

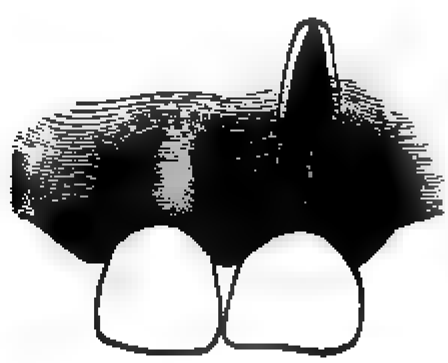
by which gold crowns with porcelain faces made of plain plate teeth are attached to natural roots.

One of these methods consists in soldering to a plain plate tooth with straight pins a narrow strip of heavy gold plate beveled on its sides toward the tooth, and long enough to form the pivot extending into the root.

When ready for insertion, gold is packed around the pivot (being anchored in the roots by means of undercuts) and behind the beveled edges of the backing, and so built up as to form a contour palatine surface on the crown. (Fig. 566.)

Another method of Dr. Webb's is to back with gold plate a plain plate tooth with straight pins, the sides of the backing being bent to form a tube or cannula. Through this tube a gold pivot passes into

FIG. 566.



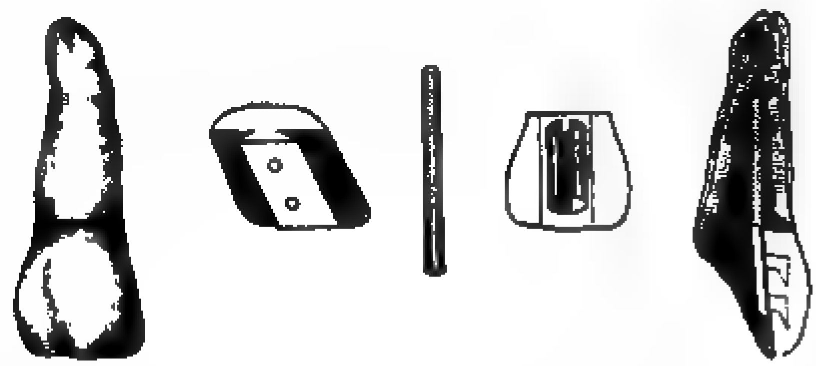
the root, and cohesive gold is employed to secure the pivot to both crown and root, by packing it around the pivot in the root, around the tube on the backing, and into the dovetailed grooves in the crown (Fig. 567). This plan is a modification of that suggested by Dr. W. H. Dwinelle, to be used in connection with crystal gold.

A method of no recent date is, to take an impression of the root surface and adjoining teeth, and to drill a hole in the plaster model thus obtained, to correspond to the canal or canals of bicuspids and molars. Into these holes gold, platinum, or platinum-and-iridium alloy pins are inserted, and to these a disk covering the exposed surface of the root is soldered. A plate tooth is then adapted by grinding and soldered to the disk, the plaster model serving as a guide for the adaptation of both pins and crown. Fig. 568 represents the tooth prepared for insertion into the root by means of gutta-percha or zinc preparation, the pins being roughened or barbed, being made square for the latter purpose. When the roots are filled with gutta-percha, the pins and crown are warmed and pressed into place.

Dr. J. F. Flagg suggests the following method of pivoting, shown

in Fig. 569, and described by him as follows: "Select plate tooth, fit it to root, and bevel it from near the pin—cervical—or pins, if cross-pins, to the labio-cervical edge. Solder a platinum pin to it as a backstay and pivot combined, leaving it rough or grooved on both sides of the pin for a retaining hold to the finishing palatal amalgam.

FIG. 567.



"Fill the root . . . . I prefer to give this ('cement') a day to harden thoroughly. In the root filling drill a hole larger than the platinum pin, as near to the palatal portion of the filling as possible, and directed slantwise to the apical centre of root-filling; then fissure-drill the hole toward the labial side of the now *oval* pivot hole. By this method the tooth is accurately placed in position, and easily held firmly in place while the pin is secured by filling the

FIG. 568.

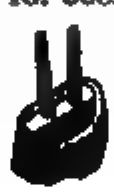


FIG. 569.

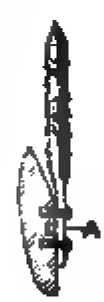
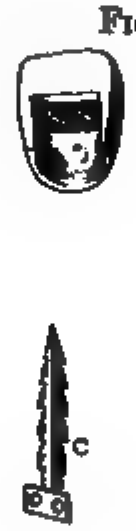


FIG. 570.



pivot hole with amalgam. Let this harden for half an hour, and then add amalgam in contour to the root filling and palatal face of the porcelain tooth. It is at this point of the operation that the need for 'beveling' the cervical portion of the tooth is demonstrated, for, by this bevel, one is enabled to make, by filling, a perfectly

tight joint at the labio-cervical junction of tooth with root, and also to secure a strength of amalgam equal to the entire surface of root-filling."

Dr. Boice modifies Dr. Flagg's method by cutting a groove across the tooth between the pins before attaching the platinum pivot, for the purpose of leaving a space behind the pivot for the better support of the amalgam with which it is filled.

Dr. H. Weston's method consists of a special crown with a depression on its palatal surface, within which are the tooth-pins and a spear-shaped pivot of hard platinum, or platinum-and-iridium alloy, notched on both edges, to the crown end of which a backing of the same metal is soldered, giving the pivot with the backing (which is to be soldered to it) a T-shape (Fig. 570). The root canal being enlarged and undercut with a wheel-drill, and the crown fitted to the root and pivot, the latter is secured in the root by packing around it either amalgam, gold, or zinc preparation.

FIG. 571.

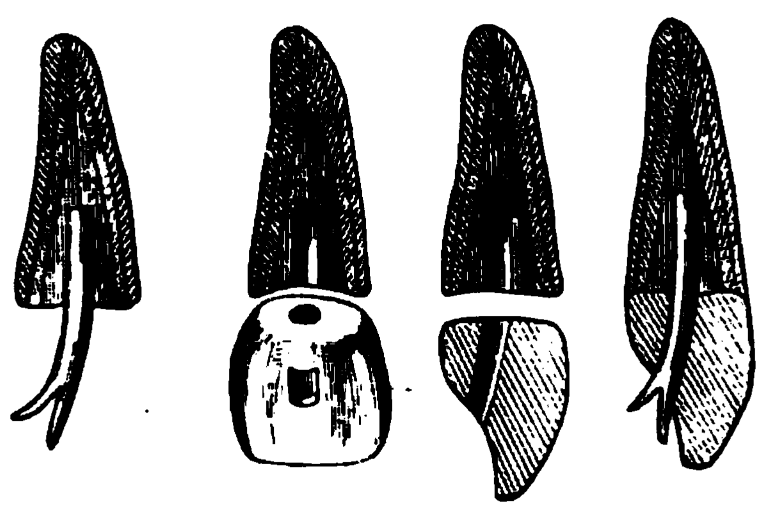
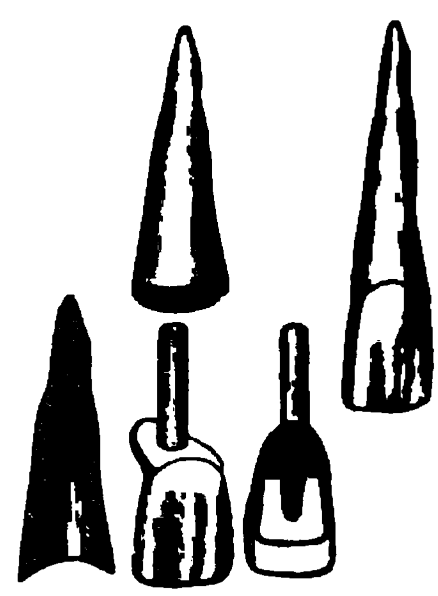


FIG. 572.



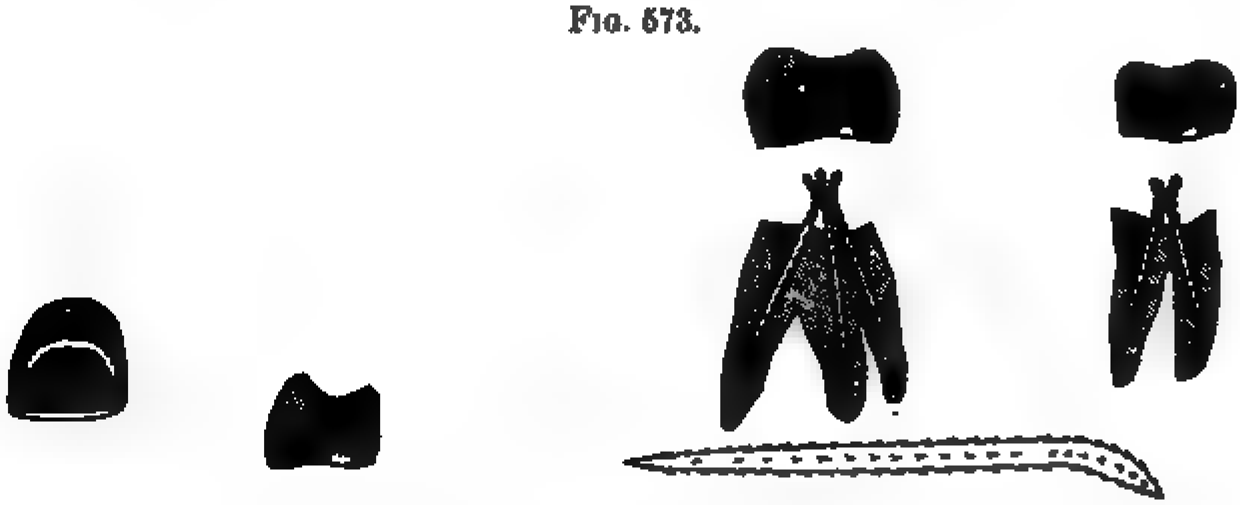
Dr. E. L. Hunter's method consists in making a pivot of gold alloyed with platinum, with a thread cut on one end, by means of which it is screwed into the root canal, the other end of the pivot being split. Several screws are inserted into the root around the pulp canal, to afford anchorage to the gold which is packed about them and the pivot projecting from the canal. A pivot crown being adapted to the root surface, the split end of the pivot is sprung open and the crown forced to its place, being firmly held by the split end of the pivot.

Dr. G. P. Carman modifies Dr. Hunter's method by using an ordinary pivot crown, with the hole drilled completely through it (Fig. 571). The split or cleft end of the pivot is made to fit loosely in the hole in the crown, so that gold may be packed around it to hold the crown firmly.

A method of pivoting devised by Dr. H. K. Leech (Fig. 572) is

described also by Dr. Dexter, as follows: The root is drilled out, to a depth of about three-eighths of an inch, to a diameter of No. 16 standard American wire gauge, the bottom of the hole being flared or enlarged and the canal above filled with gutta-percha. A gold tube is made to fit the hole accurately and project sufficiently for convenience of handling, and is soldered through a hole in a gold base struck to the root, projecting through the plate some distance. A plate-tooth is fitted to the root and plate and soldered to the latter, gold being flowed on to the plate and backing and around the projecting tube, to form the palatal contour, and the tube cut off flush with the latter. We now have a plate tooth, gold backed, with a tube pivot, the orifice of which opens on the palatal aspect of our tooth. The root end of the tube is now slit perpendicularly in three or four places, for about two-thirds of its length, a thin sheet of

FIG. 673.



warm gutta-percha is placed on the base of the crown around the tube, and the whole is pushed securely to place. Now pack gold or tin into the tube, *condensing the bottom portions so that the slit end will spread and tightly fill the flared end of the hole in the root*, and the operation is complete. Dr. Dexter suggests that tin be used to fill the tube, so that the tooth may be easily removed in case of trouble.

Dr. W. G. A. Bonwill, the inventor of the well-known "Bonwill crowns," has suggested several methods of pivoting, but the latest, consisting of an all-porcelain crown, he considers to be the best. These teeth are made in special moulds, and the incisor crowns are so shaped as to form a dovetail, which allows the strain outward to come high up near the cutting edge, and not to depend upon the palatal wall for support. The bicuspid and molar crowns are cut out at the base, leaving little more than a shell with undercuts for the amalgam, to act as dovetails, the operation being an amalgam filling capped with porcelain. The hollow crowns enable the operator to fit them to the natural roots very readily, as there is little

material to grind off. Fig. 573 represents the Bonwill crowns for the incisors, bicuspids, and molars.

Fig. 574 represents the latest style of pins for setting the Bonwill crowns being made of special metal and of a shape that allows of setting in four different directions. After the crown is fitted to the root the pulp canal is filled with amalgam in a plastic condition, and the triangular barbed metal pin is forced into it. The crown is then filled with the same substance, placed over the pin, and forced to its place, the pin resting in the hole in the crown. Several modifications of this method are suggested by the inventor, such as a nut on the end of the pin, and a gas vent formed by allowing a flat side of the pin to rest against one wall of the canal, and the space kept free of amalgam when it is packed about the pin. Retaining points are made in the root with a wheel burr, and the

Fig. 574.

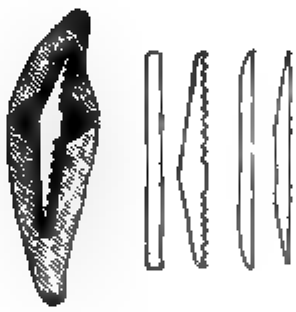
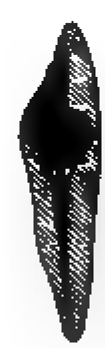


Fig. 575.

amalgam is packed in the countersunk base of the crown, and the surplus escapes by the opening on the palatal surface in the case of an incisor crown. When the crown is well pressed into its place on the root, the amalgam can be packed in around the pin. The too

Fig. 576.

Fig. 577.



free escape of the amalgam through the palatal opening in the crown can be prevented by placing the thumb and index finger on the orifice when pressing up the crown. The tooth should be kept at rest until the amalgam has hardened. Fig. 575 represents the

Gates-Bonwill crowns, which are inserted on the triangular pins in the same manner as the crowns just described.

Dr. Bonwill claims that, by means of "adjustors," Fig. 576, the crowns can be better kept in position immediately after the operation than with the fingers or forceps.

Dr. S. Davis's method (Fig. 577) is to prepare the root as usual, and ream out the chamber in a funnel shape, and cut anchorages in the

FIG. 578.

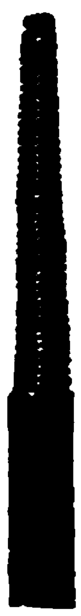


FIG. 579.

FIG. 580.

FIG. 581.

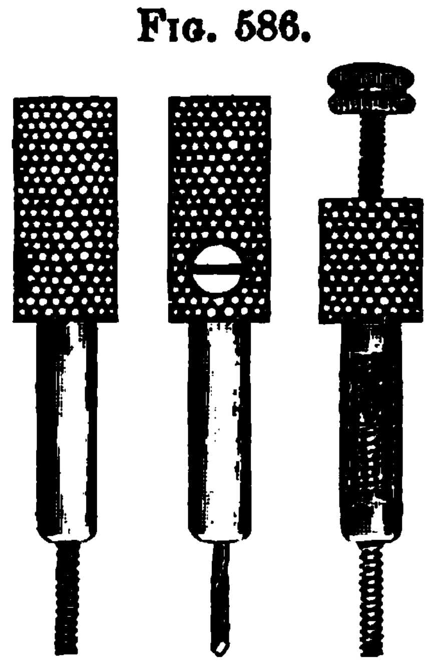
FIG. 582.

FIG. 583.

FIG. 584.

FIG. 585.

FIG. 586.



sides of the reamed surface. A plate-tooth is then fitted, by grinding it, to the labio-cervical edge of the root, and backed with gold plate, when the sides of the tooth and backing are ground to bevel sharply inward, leaving the labial surface untouched. A gold pivot is then soldered to the backing, of such a length that when it is placed in position a narrow space is left between the crown and root. The pivot and backing are then roughened, the latter being barbed and fastened into the root with oxychloride or oxyphosphate of zinc. Gold is then packed in the retaining points, the pulp chamber and around the pivot, and built upon the backing to give a proper form to the inner surface of the crown of the tooth.

The four-pin crowns, invented by Dr. W. Storer How, are among the more recent methods of pivot work, and the following description of the successive steps to be taken in mounting these crowns, with the necessary appliances, was prepared for the present edition of this work by Dr. How.

1. When the root is in proper condition for mounting, measure the depth of the canal by means of the canal plugger (Fig. 579) and its flexible gauge (Fig. 578), and fill the canal at and a short distance from the apex of the root, keeping the gauge at position to show the length of the canal, and also the distance to which it has been filled.

2. Cut off the root crown, with the excising forceps and a round file, down to the gum margin, and with the barrel burr, No. 241, cut the labial part of the root fairly under the gum without wounding it.

3. Set gauge (Fig. 578) on a Gates drill (Fig. 583), to one-half the gauged depth of the canal, and drill to that depth.

4. Set the twist drill (Fig. 582) in its chuck (Fig. 586), to project the same length as the Gates drill, and, turning the chuck with thumb and finger, drill the root to exactly that depth.

5. Enlarge the mouth of the canal, one-sixteenth of an inch deep all around to near the margin of the root, using the square-end fissure burr, No. 59, and then with the oval, No. 94, under-cut a groove at the sides and lingually, as shown in Fig. 584.

6. If the rubber dam is to be used for a gold or plastic backing, put it now over the root with Hunter's root-clamp, also over the adjacent teeth, and thoroughly dry the canal.

7. Set the tap (Fig. 585) in its chuck (Fig. 586), a trifle less in length than the drill; oil the tap and carefully tap to the gauge depth.

8. Insert the post in its chuck (Fig. 586) to the exact gauge of the tap, and turn the thumb-screw down hard on the end of the post; then screw the post into the root; release the thumb-screw;

unscrew the chuck a half turn; bend the post until the chuck stands in centre line with the adjoining teeth, and unscrew the chuck.

9. Slit the rubber back from adjacent teeth, tucking the flaps out of the way, so that occlusion may be tried, and the post excised and ground off, until the teeth close clear of the post.

10. Try the crown on the post, and with an F disk, *dry*, grind the rib between the neck pins until the crown is labially flush with the root margin, cutting a little at a time until exactly flush.

11. Take the crown and place the mandrel (Fig. 587) between the pins just as the post is to be, and, with the pliers (Fig. 588), bend the pins carefully over the mandrel, cutting off the pins if too long

FIG. 587.

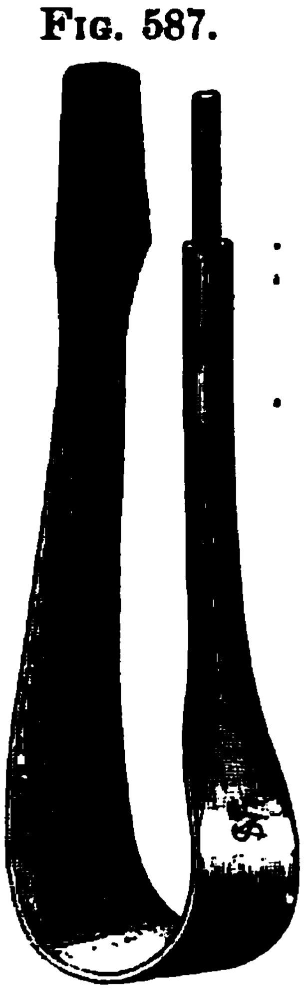


FIG. 588.

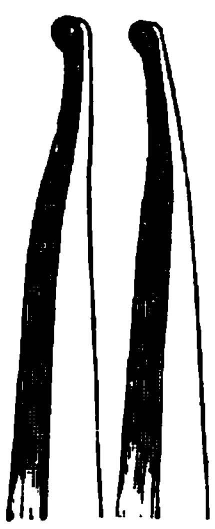


FIG. 589.

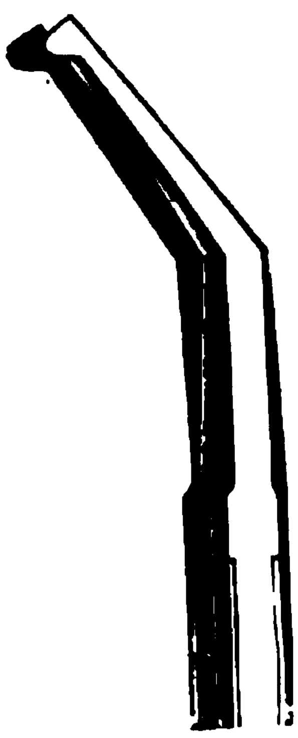


FIG. 590.

FIG. 591.

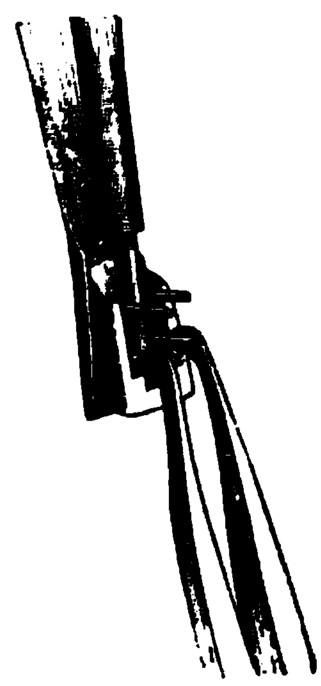


FIG. 592.

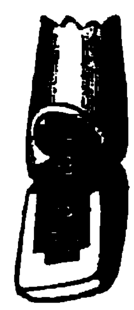


FIG. 593.

to be pinched in on the mandrel at the sides, observing that the pin nearest the cutting edge is first to be bent (Fig. 590), and the opposite pin bent *below* it on the mandrel, and so with the others (Fig. 591).

12. Slip the crown over the post, try occlusion, and with the post-chuck bend the post until the crown is properly aligned with the teeth; then with a stump corundum wheel No. 3 grind the neck of the crown to a close labial fit with the root, fitting only the portion to be concealed by the gum, leaving narrow gaps at the sides to be filled by the backing between crown and root (Fig. 592).

13. Grind the cutting edge for relation to the other teeth, being sure that the opposing tooth does not strike crown, or post, or pins.

14. Fix the crown on post by pinching the pins into the screw threads of the post with special pliers. (Figs. 588 or 589.)

15. Finally, pack the backing of gold, or cement, or amalgam, or

Wood's metal, or—for temporary backing while treating abscess—gutta-percha, into all the crevices around the post and behind and under the pins, and between the crown and the root; contour and finish thoroughly, so that no ledge or other imperfection can be found.

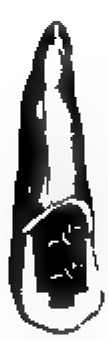
Fig. 593 shows in vertical mid-section an incisor crown mounted: the blackened portions of the backing defining the locking-hold of the backing on the post, the crown-pins, and the root recess.

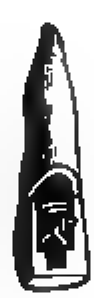
Fig. 594 shows in perspective a cuspid crown ready to be slipped over its post, and also a cuspid crown ready for its post in the bicuspid root, which has its lingual cusp remaining, and Fig. 595 shows the crowns on their posts awaiting the contour-backing.

Fig. 594.

Fig. 595.

Fig. 596. Fig. 597. Fig. 598. Fig. 599.





In mounting a crown on the bicuspid root (Fig. 594) the chucks will not usually pass the natural cusp, and hence the drill and the tap must project the cusp's length in addition to the gauge length. Observe also if the space between the tap and the cusp is wider than the thickness of a crown-pin, and, if not, cut the cusp vertically with a large fissure-burr, so that the space shall be wide enough, before setting the post, else the bent pins will not pass between the post and cusp. Grind the rib—see step 10—quite down to the floor of the crown; take steps 11, 12, and 13, and, if the occasion necessitates grinding the crown so as to destroy one pair of pins, invest the crown, and solder the pins at the lap, taking step 15 for completion.

When it is desired to contour the backing of a cuspid crown to form an inner cusp, or to adapt a cuspid or incisor crown for masticating uses, the pins may be twisted together over the mandrel, and again twisted tightly over the post, as in Fig. 596; but in some cases it may be better to bend the neck-pins, as in Fig. 597, instead of twisting them. In all cases the bent pins, are to be pinched quite hard over the mandrel and post, so that the serrations of the pliers will roughen the pins to prevent their being pulled through the backing, which should also be condensed around the pins and post.

If the root is not ready for permanent mounting, use a tubular post, or, in the absence of a threaded tube, take the successive steps up to 13; then back temporarily with wax, rubber, or gutta-percha, awaiting the next sitting, when the crown may be taken off, the

FIG. 600. FIG. 601. FIG. 602. FIG. 603. FIG. 604.

post unscrewed, and the remedy applied. Thus the root may be alternately medicated and mounted until ready for the permanent crown.

When the root is much decayed, the bottom of a cone-shaped cavity may be drilled and tapped to the depth of a sixteenth of an inch, and the post, thus anchored, may be further secured by cement in the grooved walls of the cavity and around the post (Fig. 598).

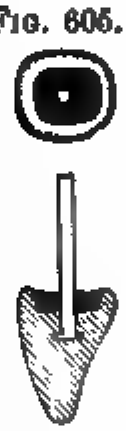
These crowns afford unusual facility for mounting by any of the well-known methods of inserting the post after soldering it to the crown. They are also adapted for use in celluloid and rubber work, especially in cases of single teeth. The several long pins, having their ends bent with pliers at a sharp angle (Fig. 599), may be so arranged as to both strengthen the shank of the plate and hold the crown very firmly in position.

The screw-posts are made of crown metal, an alloy devised for the purpose, in order to obtain a stiff post that will permit the cutting of the peculiar and extremely accurate thread formed upon it, and which will not amalgamate or be otherwise affected by any backing material that may be used. Of course, platinum or platinum alloyed with iridium may be employed for posts, but the crown metal is in every way superior.

There are some cases of a class which has hitherto presented difficulties that may now be easily overcome by grinding the post flat on the crown side after it has been set and bent in the root (Fig. 600), so as to be clear of the occluding tooth; and then the crown pins may be bent over the reduced post, the crown fitted and ground to clear the opposite tooth (Fig. 601), and the backing added.

A similar case, in which the opposing tooth and a proper alignment require an oblique bending of the pins, is seen in Fig. 602, while the reverse arrangement of parts is shown in Fig. 603. The crown is thus seen to be adapted to a wide range of adjustments because its point of contact with the root is at the labial portion of the neck, on which, as on a hinge, the crown may be swung out or in (Fig. 604, dotted lines), over an arc of at least sixty degrees, at any point of which it may be quickly and firmly fixed. The labio-cervical junction is made just under the gingival margin, and I usually interpose a thin layer of cement, amalgam, or gutta-percha, or a narrow ribbon or several large blocks of soft gold; the joint always to be made smooth, and hid from view under the free margins of the gums.

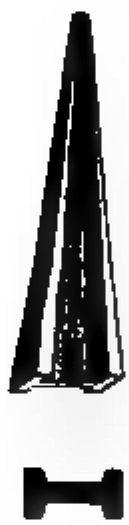
Fig. 605. Fig. 606.

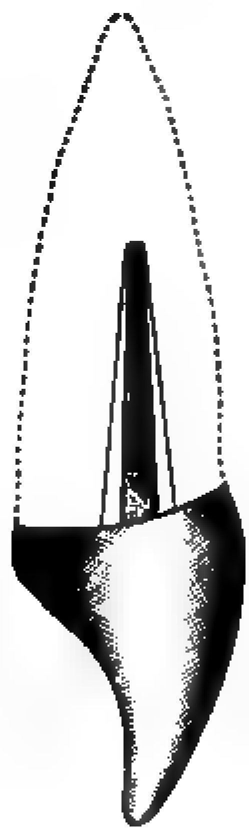


Dr. M. L. Logan has devised a porcelain crown (Fig. 605), with a round metal pin placed in position before burning the tooth. The pin extends three-eighths of an inch outside the crown, which is provided with a basal cavity intended to be filled with a cement or other retaining material, to afford additional support. Fig. 606 shows the crown in position.

Fig. 607 represents the improved Logan tooth-crown. Dr. W Storer How describes the mounting of a Logan crown as follows: "Fig. 608 shows a superior right central root, an end appearance of same, and a Logan crown, front view. Fig. 609 exhibits, at a right angle to the plane of the first figure, the same root, its end, and the Logan crown, side view. In both figures the pulp canal is supposed to have been first drilled to a gauged depth with an engine twist-drill, No. 151, and then enlarged by means of a fissure-burr, No. 70,

FIG. 607.





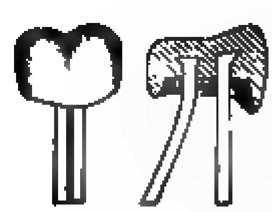
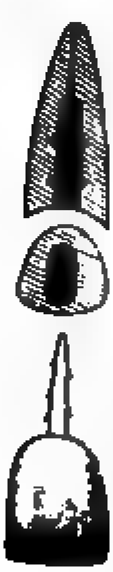
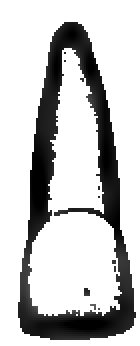


FIG. 608 FIG. 609. FIG. 610. FIG. 611.





to the tapering form shown; the walls being subsequently grooved with an oval burr, No. 90. The enlarged section, Fig. 610, shows the crown adjusted on the root by means of cement or gutta-percha, which surrounds the post and fills all the spaces in the root and crown. Fig. 611 shows the completed crown. Fig. 612 exhibits a

FIG. 612. FIG. 613.

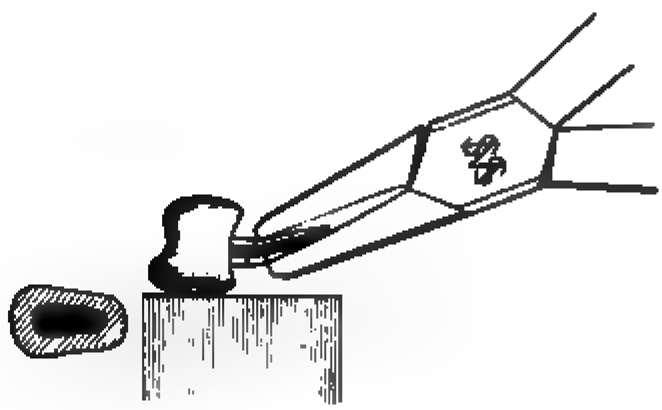


FIG. 614. FIG. 615.

bifurcated bicuspid root, its end appearance, and a Logan crown adjusted to the root. Fig. 613 illustrates the best manner of beading the post. Fig. 614 shows a split post, and its adaptation to a bifurcated bicuspid root is seen in Fig. 615. Figs. 616 and 617

FIG. 616. FIG. 617. FIG. 618. FIG. 619.

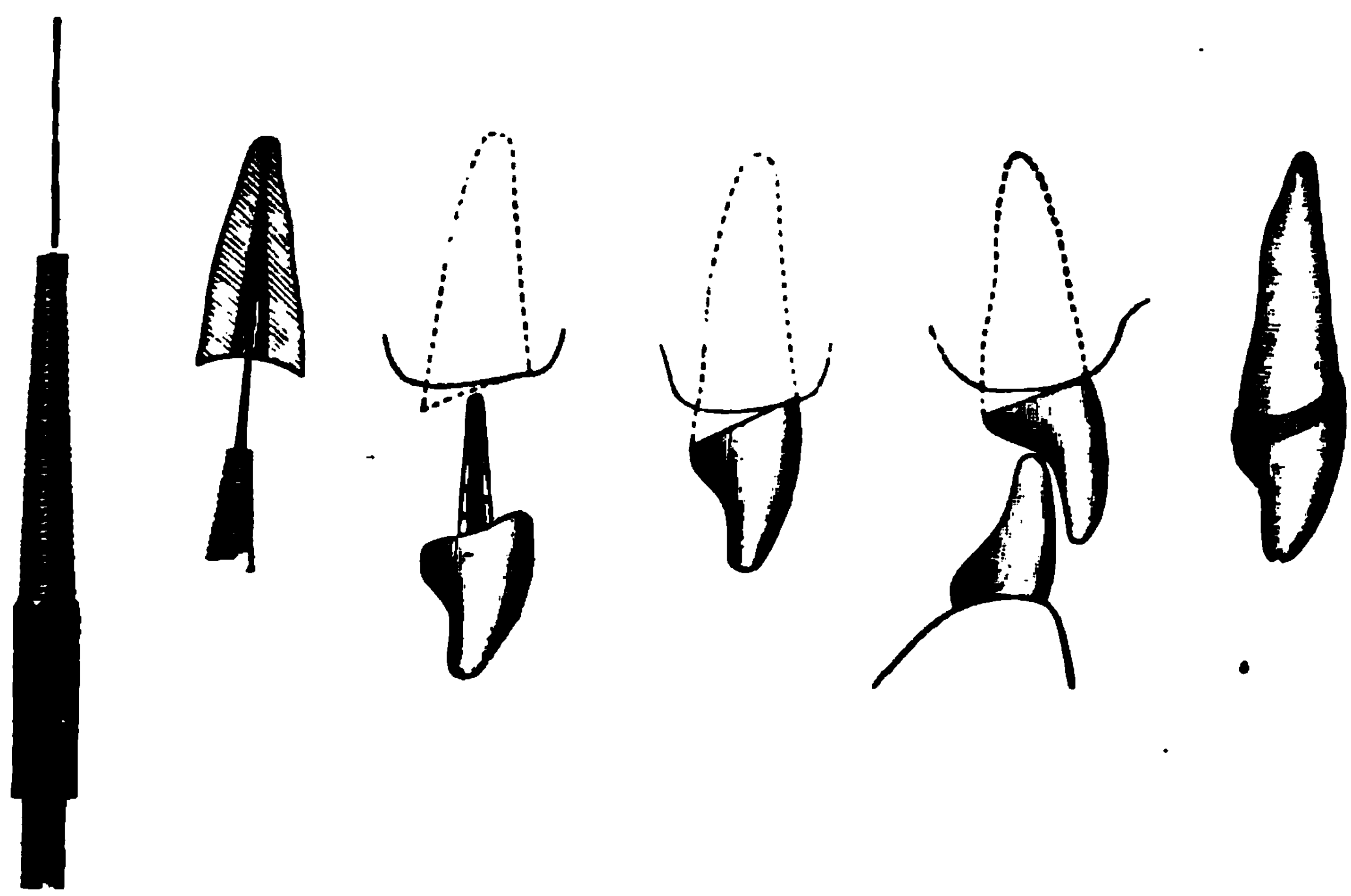
exhibit the mode of mounting the Logan crown on a superior molar root, and Figs. 618 and 619 the same crown in its relation to an inferior molar root.

"In the preceding description the figures clearly present to the mind's eye of the expert dentist the essential features of the new Logan crown and the method of mounting it; yet further explanation with reference to the figures will perhaps prove serviceable to such as may not be familiar with all the details of root-crowning.

"In every instance where a root is deemed ready to receive its filling, it should first be measured through its canal from the cervical opening to the apical foramen, and this may be accurately done with a gauge adjustable on a delicate canal explorer, Fig. 620. The

same device serves to measure the distance from the apex to which the canal should then be filled (Fig. 621). It also gauges the depth to which the drill may be carried. The proper degree of enlargement from the bottom of the drilled hole will, of course, depend on the observed size and character of the root, and every dentist should familiarize himself with generic tooth-forms, so that when the length of an incisor, cuspid, or other tooth-root is known, he can so nearly determine its hidden outlines as to form with precision a corresponding enlargement of the pulp canal such as is shown by the several cuts. The suitable preparation of the bifurcated roots of some bicuspids and of all the molars is a matter involving difficulties and judgment of an unusual character. An instance of the

FIG. 620. FIG. 621. FIG. 622. FIG. 623. FIG. 624. FIG. 625.



feasibility of splitting the post of a Logan crown to adapt it to the bifurcated root of a bicuspid is shown by Figs. 614 and 615. This example directs attention to the peculiar shape of the new post, in which there is effected such a distribution of its metal that its greatest strength is in the line of the greatest stress that will in use be brought to bear on the crown, while the least metal is found at the point of the least strain; the applied part of the post being in outline nearly correspondent to that of the root itself. The pulp-canal is likewise conformably enlarged to receive the largest and stiffest post compatible with the size and shape of the root to be crowned.

"The fitting of a Logan crown to a root is best done by the use of a wet stump wheel in the engine hand-piece, which affords the

greatest facility for the slight touches required to abrade the thin cervical borders of the crown, which may thus be made without encroachment on the post.

"By the old method of adapting pivot teeth to roots, the close fitting of the crown precluded the use of a plastic packing, because its thinness over the surface of the joint made such packing liable to break loose under the shock and strain of use. The recess in the Logan crown obviates this defect by providing a receptacle for a considerable interior body of cement that will be deep enough to be self-sustaining internally, and yet allow the peripheral portions of the root and crown to approach each other so closely that, though only a film of packing remain, it will still be strong enough to insure the persistent tightness of the joint. Such annular boss of cement when formed of amalgam also adds strength in some cases to the mount.

"When enough of the natural crown remains, it is well to leave standing some of the palatal portion, and cut the root under the gum-margin at only the labial part, as shown by Fig. 622. Thus, the labial-joining of the root and crown will be concealed, and the other parts of the joint will be accessible for finishing and keeping clean (Fig. 623). The Logan crown may be ground until a large part shall have been removed for adaptation to the occluding tooth or teeth without greatly impairing its strength (see Fig. 624). This crown also in such cases maintains the translucency which is one of its peculiar excellences, owing to its solid porcelain body and the absence of a metallic backing or an interior largely filled with cement or amalgam.

"The distal buccal root of the natural superior molar is in nearly every instance too small to receive a post of any useful diameter, and therefore the Logan superior molar crown has but two posts, which, like those of the inferior molar crown, are square, and thus may be easily barbed, as may also the ribbed posts of the crowns for the anterior tooth-roots. These posts are in all the Logan crowns large enough to answer in any given case, and can, of course, be easily reduced to suit thin or short roots.

"Any of the cements or amalgams may be used in fixing these crowns, but good gutta-percha, softened at a low heat and quickly wrapped around the heated crown post, which is at once seated in the root, forms the best mounting medium, and has the great advantage of permitting a readjustment, or if need be the ready removal of the crown by grasping it with a pair of hot pliers or forceps, and holding it until the gutta-percha is sufficiently softened.

"An excellent combination for some cases is accomplished by fit-

ting a narrow seamless gold collar over the neck of the root prepared like that of Fig. 623, and then adjusting and mounting in the manner described a Logan crown, with the results shown by Fig. 625."*

For reaming out and grooving the walls of the root-canals, Fig. 626 represents what is known as the "grooving burr engine-bit." This burr is intended for cutting grooves in the walls of root-canals to provide retaining-points for plastic materials in setting porcelain crowns. The grooves are made by sweeping the burr, while in motion, around the walls of the canal, which should be made large enough to permit the burr end to reach the bottom of the cavity. Two or three grooves, as may be desired, can be cut in thin roots with safety, one size of the burr answering for all cavities. The

Fig. 626. Fig. 627. Fig. 628. Fig. 629.

Reamers. Facers.

canal is then filled with gutta-percha, oxychloride, amalgam, or other plastic, and before it sets the barbed pin of the crown is inserted, with the effect of forcing the material into the grooves, thus adding greatly to the strength of the operation.

Fig. 627 represents Dr. Ottolengues' root-reamers and facers.

The root-reamers are of the size and taper of the Logan crown-pins Nos. 1, 2, 3, and have corresponding numbers. With a drill just the diameter of the smooth end of the reamer, the root should be drilled to the proper measured depth and the bored canal be then enlarged with a suitably numbered root-reamer, which, having a smooth end, cannot be forced beyond the end of the drilled hole.

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* *Dental Cosmos.*

There are five sizes of the root-facers, so that one may be chosen of such width that the root end can be smoothly, quickly, and safely faced to fit the crown.

Dr. C. M. Richmond has devised a modified form (Fig. 628) of the last described crown, which consists in making the pin square instead of round, to prevent the crown from rotating, and in forming an opening on the palatal and lingual surface of the basal cavity, for the free escape of the filling material when placing the crown in position. Dr. Richmond suggests that a quick-setting material, such as oxyphosphate of zinc, be used in the bottom of the cavity, and amalgam at the surface. Fig. 629 shows the modified crown in position.

A new crown has recently been invented by Dr. Richmond, and the mode of mounting it is described by Dr. How as follows:—

" A superior central incisor root will serve as a typical case, and its projecting end is to be shaped as seen in Figs. 630 and 631. This can be rapidly done with a narrow, safe-sided, flat, or square file,

FIG. 630.

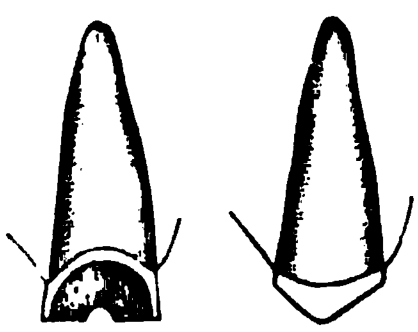


FIG. 631.

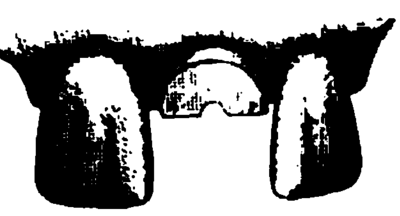
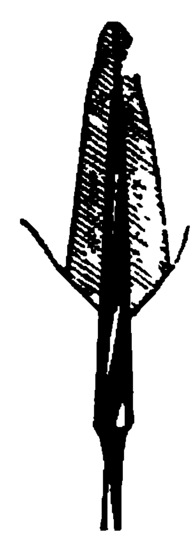


FIG. 632.



the angles of the slopes being such that the gum on the labial and palatal aspects will not interfere with nor be disturbed by the operator in this preliminary work, for the root-end is not at this time to be cut quite down to the gum. A root-reamer is then employed to bore out the root to receive the crown-post, which is of the same size and shape as the Logan crown-post for a central incisor. Fig. 632 shows in section the relation of the reamer to the root. The new Richmond crown, Fig. 633, is then put on the root (see Fig. 634), and its position relative to the adjacent and occluding teeth noted. If the cutting-edge of the crown is to be brought out for alignment with its neighbors, the root can be drilled a little deeper and the reamer pressed outward as it revolves to cut the labial wall of the cavity. The palatal root-slope must then be filed to make the V correspond to the changed inclination of the crown.

"Thus, by alternate trial, and reaming, and filing, the crown may be fitted to the root and adjusted in its relations until the post has a close, solid bearing against the labial and palatal walls of the enlarged pulp-cavity, and the crown-slopes separated from the root-slopes by the thickness of a sheet of heavy writing-paper. This space can be accurately gauged, and the root-slopes conformed to the crown-slopes by warming the crown and putting on its slopes a

FIG. 633.

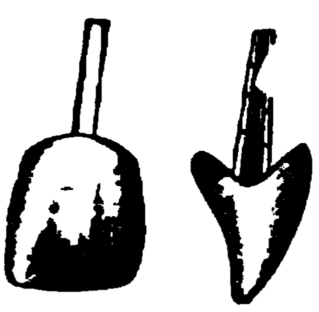


FIG. 634.

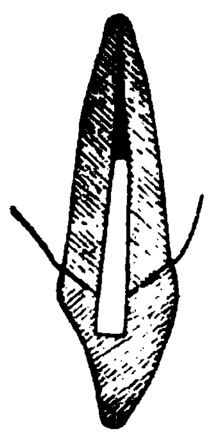


FIG. 635.

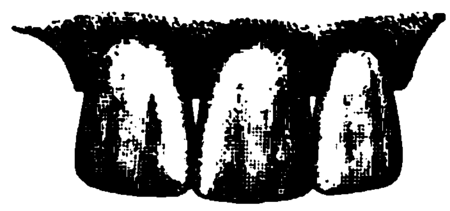
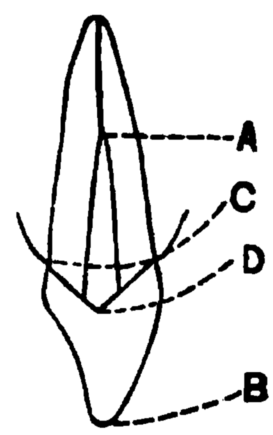


FIG. 636.



little gutta-percha, so that an impression of the root-end may be taken, and the root-slopes dressed with a file until the film of gutta-percha proves to be of equal thinness on both slopes. After thus completing the adjustment, with due attention to the alignment and occlusion, the crown and the root are to be dried as thoroughly as possible.

"To do this effectively in the root, it should first be swabbed and washed out with absolute alcohol, and then continuously flooded with

FIG. 637.

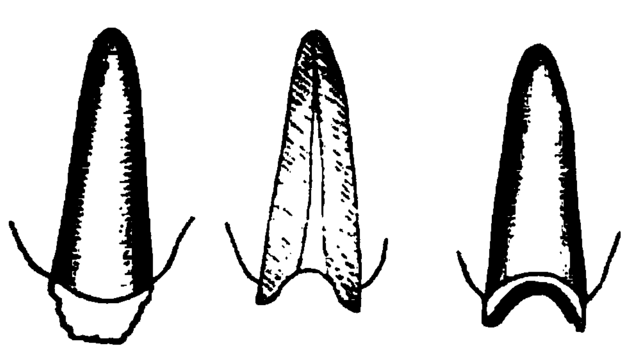


FIG. 638.

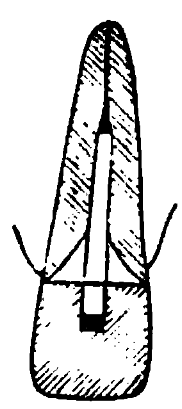
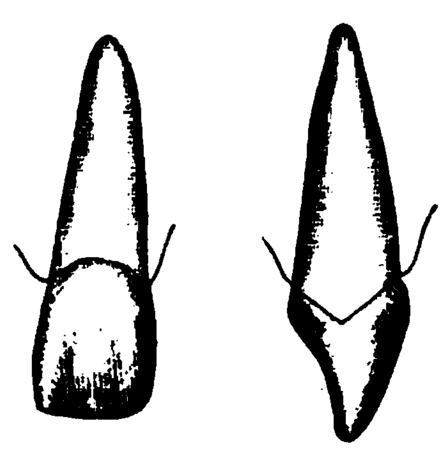


FIG. 639.



warm air, until the root is not merely dry, but dried throughout as far as possible, and made so warm as to render the patient conscious of its heat. A little gutta-percha is then put on the sides of the post and over the slopes of the crown, which is then pushed into place, the exuding gutta-percha cut away, and the joint smoothed with a warm burnisher. The film of gutta-percha should be *very thin*. The crown and root may be quickly cooled by the use of the syringe with cold water, and the patient then enjoined to let the crown rest for a few

hours in order that the gutta-percha may become quite set. Fig. 635 shows the completed crown.

"Dr. Richmond usually takes a thin, perforated disk of gutta-percha, pushes the post through it, warms the crown, presses it into place, and when cooled removes the crown, and with a sharp knife trims away the gutta-percha close to the crown-neck. He then warms the crown, puts a very little oxyphosphate cement on the post, and presses the crown home.

"The obvious advantages of the device are the readiness with which the slopes of the root end may be shaped with a file; the facility with which these slopes may be given any angle to set the crown out or in at the base or at the cutting edge, or to give it a twist on its axis; the certainty that, once adjusted, the final setting will exactly reproduce the adjustment; the assurance that in use the crown will not be turned on its axis,—a most common cause of the loosening of artificial crowns; the firmness of its resistance to outward thrust in the act of biting. This fact is made apparent by Fig. 636, wherein it will be seen that in an outward movement the crown B would rock upon A as a pivot, and the dotted line D shows how the crown slope is resisted by the root-slope, which extends so far toward the incisive edge that a much firmer support is given to the crown than if the resistance should be, as it usually is, on the line of the gingival margin C.

"The cases for which the new crown seems specially adapted are such as have some considerable portion of the natural crown remaining, and for these it would seem that no better artificial substitute has yet been made accessible to the profession.

"For roots that have become wasted below the gum-surface the new crown is not suitable, except in such cases as are decayed under the labial or palatal gum-margin only, but have yet projecting the approximal portions of the crown (see Fig. 637).

"The sectional view (Fig. 638) and the perspective plan views (Fig. 639) illustrate the manner of mounting these crowns on this class of roots. The finished crown appears as in Fig. 639."

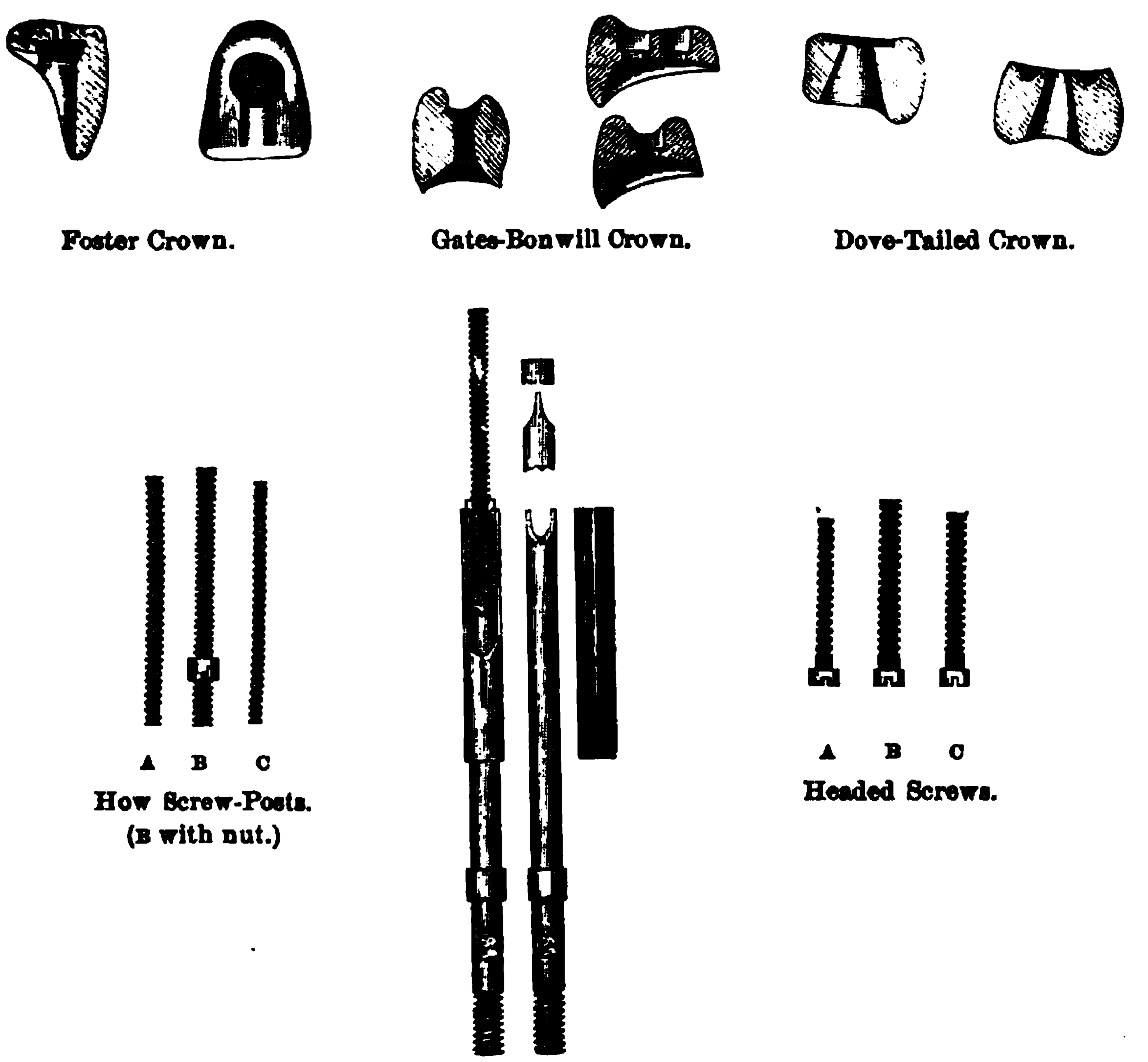
Fig. 640 represents different forms of crowns, and the nut-driver and screw-nut for setting porcelain crowns on natural roots.

The all-porcelain crowns, such as the Foster, Gates-Bonwill, dovetail crown, and others, have been set in various ways, prominent among which has been the use of solid-headed screws; but we find that much more satisfactory and firmer work can be done by first fixing the screw-post in the root, thus permitting the crown to be slipped over the end of the post and properly adjusted to the root, after which the cavities in both root and crown may be partly filled

and a nut screwed on the end of the post to condense the filling and firmly secure the crown in its place. These appliances are very simple. They consist of a nut-driver, over which is placed a split tube for carrying the nut (see sectional view). The sole object of this tube is to hold the nut and prevent its falling into the mouth or on the floor during the process of attaching or detaching it from the post.

The substitution of pieces of porcelain for the portions of crowns of teeth destroyed by caries, by a process of inlaying, was suggested

FIG. 640.



Foster Crown. Gates-Bonwill Crown. Dove-Tailed Crown.

A B C
How Screw-Posts.
(B with nut.)

A B C
Headed Screws.

Nut-Driver with Split Tube.

many years ago by Dr. Edw. Maynard, and successfully practiced by Dr. A. J. Volck, of Baltimore, and also by Dr. B. Wood. Dr. W. Storer How describes a method as follows: * —

"One of the chief obstacles to success in many of these operations has been the difficulty of exactly fitting the inlay to the tooth. There is, however, a class of cases which, by methods that will be now described, may be repaired with the certainty of gratifying results.

* *Dental Cosmos*, August No., 1888.

"A typical instance is that illustrated in Fig. 641, and the filling of gold usually inserted in such a cavity is a glaring disfigurement, endurable only by reason of the necessity of preserving the life and usefulness of the tooth. Fig. 641 also shows the oval-shaped cavity about to be converted into a circular one by means of a wheel burr, as, say, No. 208. A fine-cut burr is essential for this work, which requires skill and delicacy with firmness of touch in order to the making of a truly circular cavity of the smallest diameter consistent with the inclusion of all the borders of the original cavity. When this has been nearly done, and the cavity suitably deepened by an excavating wheel-burr, as No. 22, the barrel-burr, say No. 239, is to be used with steadiness and due attention to the holding of it, so that when pressed quite to the bottom of the cavity the margin will be exactly circular, whenever that is possible. (See Fig. 642.) In some cases the differences between the diameters of the successive or even the same numbers of the finishing burrs will be found too great, so that while one size is not quite large enough, the next size is much too large. It is best, therefore, to be prepared with

FIG. 641.

FIG. 642.

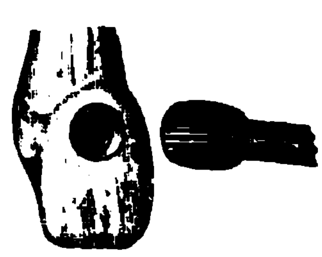
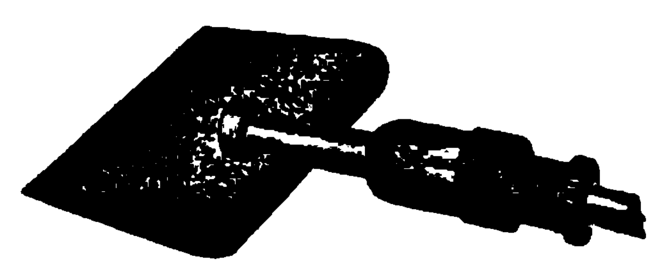


FIG. 643.



some hard-wood points, in shape like the wood polishing-points No. 3, and of closely graded sizes, to be used in the porte-polisher No. 307. A thin strip of bone or ebony or vulcanite should also be at hand having a series of holes that may be made with the barrel burrs, each of which will make three different sizes, and the strip serves as a very useful gauge. Selecting then a hard-wood point (one made of copper or of tin-solder would be even better) a very little larger than the cavity, put in it some corundum polishing-paste and carefully grind the cavity larger, circular, and true down to the bottom. Of course, it is next to be thoroughly washed out with alcohol and dried with warm air. With a wheel burr No. 15, or oval No. 91, cut small grooves in the upper and lower walls, but not on the thin side-walls, which would thus be needlessly weakened. Select from the stock of broken or whole porcelain teeth, whether plain-plate, vulcanite, or gum teeth, one which will match the color of the natural tooth, and, with a corundum disk or other wheel, cut out a section somewhat larger than the cavity. But when a stock of cavity-stoppers is accessible, one of these will be preferable

because made wholly of enamel, and therefore likely to take a better polish in the process of finishing.

"It is worth while to spare no trouble or time or expense in matching as near as possible the exact shade of the tooth to be inlaid, because the success of the substitution will greatly depend upon the closeness of its resemblance to the natural tooth. In an emergency choose the lighter rather than the darker shade. When the suitable tooth has been found, and ground to an approximate diameter and thickness, cleanse thoroughly its enamel face with alcohol, and then with shellac melted but not burned, stick the face of the porcelain to the flat-faced end of a wood-point in the porte-polisher. After the porcelain has become quite cool, try it severely to be sure that it has stuck fast, because it will be annoying and cost valuable time if it shall be dislodged and need to be reset when nearly finished. For the purpose of illustration, a cavity-stopper is selected, and is shown mounted with shellac on a wood-point. The porte-polisher is put in the engine hand-piece and rotated in contact with a corundum wheel or slab, Fig. 643. For more rapid grinding it may be rotated in contact with a revolving corundum wheel. The gauge previously mentioned will serve for frequent trials in the successive holes until the inlay fits the hole next larger than the cavity. Then the successive trials must be made in the cavity itself until, after grinding on a piece of Arkansas stone, the inlay exactly fits the cavity. In some instances it will be best to wet the inlay with a very fine polishing-paste and grind it in the cavity. This is, however, somewhat hazardous, because of the liability of the inlay to get stuck fast in the cavity, and so endanger the cavity-walls. It is then best to grind on the corundum slab the bottom of the inlay, to allow it to settle in the cavity and take up the space previously occupied by the paste between it and the cavity-walls. A fitted inlay will resemble Fig. 644, and for greater security after it shall have been mounted, it will be necessary to cut with a sharp corundum disk notches on opposite sides of the inlay; and to insure the coaptation of these notches with the grooves in the cavity, and at the same time be sure that the inlay shall shade properly with the tooth, it will be best to detach the inlay from the wood before cutting the notches (Fig. 645). Both the cavity and inlay must be perfectly clean and dry before the inlay is lightly placed in the cavity, to determine which is its upper and which its under edge, so that the notches may be correspondingly cut with a clean, sharp, dry disk. Another reason for so cutting the notches is found in the fact that sometimes the lateral curve of the surface of the tooth will be so great that a groove on the lateral wall

of the inlay would jeopardize the closeness of the joint on the surface at that point.

"It will, of course, be understood that the process described with reference to the porcelain cavity stopper is applicable to the preparation of any section from a porcelain tooth, and at this stage of the proceedings it is assumed that the clean, dry, notched porcelain inlay closely fits the clean, dry, grooved cavity. These are to be fastened to each other mainly by a locking-bit of cement or gutta-percha in each of the notches and grooves, in addition to a mere film of such plastic material between the cavity and inlay walls. This is the critical period of the operation, because of the extreme difficulty of so nicely proportioning and evenly distributing the cement or gutta-percha that the joining of inlay and tooth shall be complete in the actual contact of the marginal walls, excepting only the interstitial porosities which are to be filled with the cement or gutta-percha.

"It is probable that the generality of operators will do best with the phosphate of zinc cement, but in any case, whatever the material of union is to be, the invariable prerequisites are—perfect dryness of both the cavity and the inlay, and some degree of warmth in each of them. These conditions may be best accomplished by a thorough washing of both with absolute alcohol, and the use of the hot-air syringe immediately preceding the mixing of the cement. This should be mixed quickly and thin, and a mustard-seed bit of it taken on the blade of a small excavator and placed in the two grooves of the cavity, as also in the two grooves of the inlay; to be instantly followed by the rubbing of the walls of the inlay all over with the least possible cement on the tip of the finger. The inlay is then at once seated in the cavity and with a quick back-and-forth grinding motion pressed firmly into place (taking care that the notches are in right relations to the cavity-grooves), and held under pressure fully five minutes. In cases wherein the inlay has been ground into the cavity, it may be better not to remove the inlay from the mandrel, but to thinly coat its walls with cement and, using the porte-polisher as a handle, turn the inlay into its seat (as a ground stopper into its bottle) with such firmness as to detach the inlay from its shellac attachment to the wood-point, and leave the inlay stuck fast in the tooth. A little white wax is then melted around the joint with a hot burnisher, and the patient dismissed for a subsequent sitting, at least five or six hours later; for it is of great importance that the cement be allowed to get hard before any strain is put upon the inlay. It is also essential to the proper seating of the inlay that no cement be allowed on the floor of the cavity

or the bottom of the inlay, because no amount of pressure will bring the walls into contact if there is a body of cement between those two flat surfaces; and continued pressure for a short time after the seating is necessary lest the elasticity of possibly occluded air lift the inlay from its seat before the cement or gutta-percha shall have stiffened sufficiently to hold it in place.

"The rough grinding of the protruding portion of the inlay (Fig. 646) may be done with a stump or crown corundum wheel, until the margins are nearly flush with the tooth-surface, and then a beveled corundum point like No. 7 or No. 12 may be used, as shown in Fig. 647, to make the inlay conform closely to the contour of the tooth, and the final finish will best be given by an engine Arkansas stone beveled like 'R' or 'T' and used with its further side in contact with the inlay or tooth, or both, as the case may be (Fig. 647). Such use of the side of a grinding or polishing wheel avoids

FIG. 644.

FIG. 645.

FIG. 646.

FIG. 647.

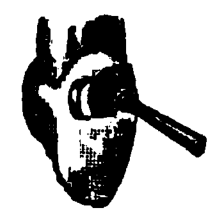


FIG. 648.

the hollowing or wavy lines which commonly result from the peripheral contact of wheels or points with the convex surfaces of the tooth. Indeed, the preferable polishing instrument would be a device like the old engine reciprocating porte-polisher, if it could be given power enough to be effective. A magnifying-glass will aid in making sure that the finish leaves the inlay border quite flush with the enamel at every point.

"A small beveled Arkansas stone wheel is almost a necessity for making the inlay flush with the enamel, because the hard stone not only cuts the porcelain smoothly without acting also upon the enamel by its detritus, as is the case with the soft stones when the enamel and inlay surfaces are nearly in the same plane, but it has a peculiar feel under the hand when cutting the porcelain and also emits a peculiar sound, so that, although the water and debris may hide the joint from view, the operator can know by the touch when the wheel is acting upon the inlay or the tooth. This is of great consequence in order that only so much, and yet every whit of so much, porcelain may be cut away as shall suffice to make the best possible joining, while preserving all the enamel essential to a flush contact with the inlay and a suitable contour of both at the finish.

"Previous to attempting this method of repair, it is advisable that

there should be some preliminary practice in setting inlays in teeth which have been extracted, or in pieces of ivory or bone; because there will thus be developed practical points which cannot be here described and yet are essential to the proper performance of the operation.

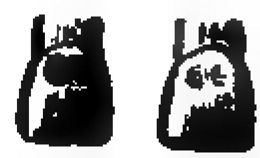


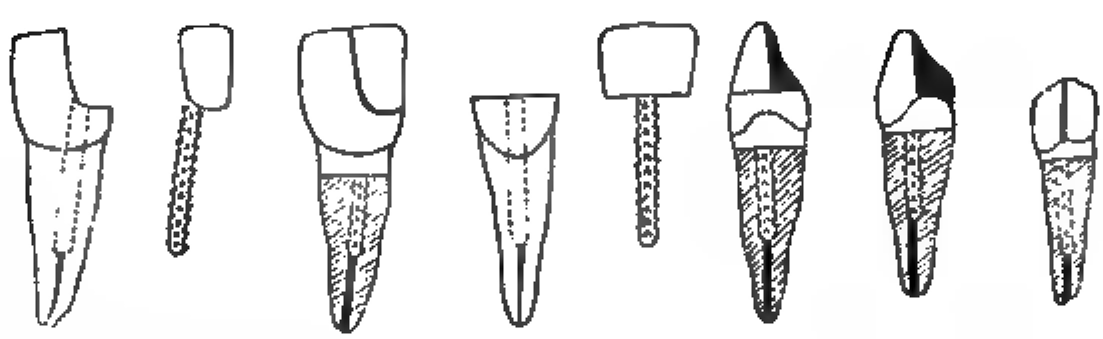
FIG. 649. FIG. 650.

"The completed inlay, Fig. 648, when suitably adapted and finely finished, may well be considered as exemplifying the nearest approach to perfection in the accomplishment of dental repair that has as yet been achieved."

Dr. S. D. Rambo has suggested a method of restoring broken crowns of teeth with pieces of artificial teeth in connection with pivots, which he describes as follows:—

"Beginning with a central incisor, with one-third of the crown broken off, as in Fig. 651 A, I fill the root with lead-wire, as follows: From a piece of sheet-lead I cut a strip and pass it through a draw-plate until it is reduced to the size of a medium pin; cut the wire into pieces one inch long and roll one end to fit the foramen at the apex. If, in passing it up, I find that it goes through (which I ascertain from the pain produced), I take it out and cut the point off

FIG. 651.



A. B. C. D. E. F. G. H.

a little and try it again. When I find that it has closed the apex exactly, which I know from the touch, I pass down by the side of it a nerve-plugger the same shape as the lead needle introduced, making room for another wire, and so on until I find the first third of the root filled. I then fill the middle part with gutta-percha, cutting the wires off as far up as I can, otherwise

the lead might discolor the tooth at the margin of the gum. I then fill the last third of the root with oxyphosphate cement, to prevent the tooth from turning dark. Before introducing the lead wires I moisten them with phenic acid or creosote. Lead is less irritating in the flesh than any of the other metals. I have found buckshot in deer that had long since healed over, with no sign of inflammation or ulcers. For the reason that flesh will kindly heal around lead, I think it the best material that can be employed for filling the roots of teeth. Next, drill a hole, as if for a pivot, and shape the rough edges of the crown more or less as in Fig. 651 A. Select a plate tooth having pins parallel with the sides, the exact shade of the tooth to be operated upon, and grind it to fit the part to be replaced. (See Fig. 651 B.) Back the piece of artificial tooth with a thin platinum plate, cutting the pins off smoothly with the backing, and secure it by splitting the heads of the pins. Then put the platinum wire into the hole drilled for the pivot, inserting it loosely, and bending to such a shape as to touch against the walls so that it may occupy the same position when replaced. Attach the piece of tooth to the wire (which is already in the tooth) with wax, leaving a space the thickness of a 00 file between the natural and piece of artificial tooth. Now draw the wire out very carefully, to guard against displacing the piece of tooth; invest in plaster and solder with pure gold. Make the backing thick enough to give the necessary finish to the tooth. Next, dry the hole with hot air; put the piece of tooth in its place with enough plastic filling (either gutta-percha or oxyphosphate) around the wire to fill the interspaces; then cut out the material in the joint to the depth of two lines, fill in with gold, and finish with disks, etc. The crown is now restored (see Fig. 651 C) with something that does not attract so much attention, which is more lasting and is far more artistic, with less fatigue to patient and operator than if it had been restored with gold.

"Fig. 651 D represents a central incisor having two-thirds of the crown, parallel to the cutting edge, broken off. In a case of this kind fit a point to the crown and proceed in the same manner as described in the preceding case. Fig. 651 E shows the piece of porcelain tooth prepared, and Fig. 651 F a side view of the restored crown. All except that portion of the broken surface of the natural tooth that is not covered by the artificial piece must be covered with a thin platinum plate, with a hole through it to permit the wire to pass. This is done in order to have a wall to flow the solder against, and to make the piece the required thickness at the joint. Cases like Fig. 651 A sometimes require similar treatment. When

there is plenty of space on the palatal surface, retaining pits may be made, and the shape restored by building gold against the backing of the artificial tooth. The latter requires more time and is, perhaps, no better, if as good, as the former.

"Many, no doubt, would cut off the remainder of the crown in a case like that shown in Fig. 651 D and pivot. But I consider tooth-structure too valuable to be thus lost, to say nothing of the difficulty of making a joint beneath the gum so perfectly as to prevent the accumulation of vitiated secretions around it. I, therefore, save all I can, not being particular where the joint is made. Another advantage in having the joint at a distance from the gum is, that the root is less liable to decay. Still, even when the crown is entirely lost (see Fig. 651 G and H), I find the above method a good one for pivoting, using gutta percha to secure the tooth in position and to prevent the secretions from entering the joints, trimming smoothly the excess of gutta-percha around the joint.

"Bicuspids and molars (see Figs. 652 and 653), having very large buccal or approximal cavities extending into the grinding surface, can be easily managed by fitting pieces of artificial teeth into cavities. If the teeth are dead the pieces may be more perfectly secured by soldering a wire and extending it down the root. In operating on a superior molar, use a long wire for the palatal root, and a shorter one may be placed on the opposite side as a brace. Excavate the material as described and fill around with gold."

It remains briefly to refer to the application of vulcanite to the pivoting of teeth.

The following method admits of variations to suit a metal pivot, rubber pivot, or the usual hickory pivot. Prepare the root as usual, being careful to drill the canal with utmost uniformity and smoothness. Have a set of very smooth aluminum pins, about a half-inch long, to suit the canals made by different-sized drills; select one which will fit accurately into the root, yet can be easily removed, and press it to the bottom of the canal, letting it project below the root a fourth of an inch. Carefully take a plaster impression of the root and two adjoining teeth in a small wax or tin-foil cup; when quite hard break it in the line of the arch and remove. The pin may come with the plaster or remain in the tooth; sometimes the break in the plaster will be just at the pin; but when pressed together the hole will be entire. Into this hole place the pin, if yet in the tooth.

FIG. 652.

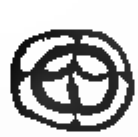


FIG. 653.

Soap this impression and make, with great care, a model, using the finest plaster; when the plaster has fully set, remove the impression piecemeal, so as not to injure the model, which should then be hardened with dilute soluble glass.

The model, with its projecting aluminum pin, is now ready for fitting and attaching the tooth; this may be retained—1. *By a hickory pivot;* in which case select a plate or rubber tooth, which will not interefere with the pin; fit it to the root, the front edge alone touching; arrange the wax and set in flask for vulcanizing. When finished, draw the aluminum pin; in the hole insert a compressed hickory pivot, and proceed as with a porcelain pivot tooth. There are three advantages in this kind of pivot tooth; it fits the root accurately, canals in root and tooth are of same size, and are also exactly in line—three points which cannot always be secured in an ordinary porcelain pivot tooth. If a plate tooth is used, a loop or hook must be soldered to the tooth pins, passing around the aluminum pin. 2. *By a metallic pivot;* in which case fit a crown to the root as before. If an aluminum pivot is preferred, the one already in the plaster may be retained, the projecting part roughened with a file, and the wax then arranged and the piece prepared for vulcanizing. If a gold pivot is preferred, carefully draw the aluminum pin and replace with a gold one of exactly the same size. 3. *By a vulcanite pivot;* in which case a plain vulcanite tooth may be used, first carefully drawing the aluminum pin; then set a small wire in the hole, extending downward behind the tooth, to strengthen the pivot. Apply wax and prepare for vulcanizing.

Lining the root canal with a gold cylinder, filling a conical cavity with foil, or any other preliminary preparation of the root, does not modify the processes just described; but among the advantages of the vulcanite pivot tooth is the readiness with which it fits an irregular surface; hence, a root hollowed by decay need not be filled, provided there is sufficient length of sound root for the canal. Another advantage is the firmness given to the close fitting of the rubber to the base of the root.

A method of applying hard or vulcanized rubber to pivot work has been suggested by Dr. J. Richardson, and is briefly described by Dr. J. E. Dexter, as follows: "An ordinary pivot crown is loosely fitted up with a wood peg, which also fits loosely the canal in the root. The crown is ground from before backward so as to leave a space between the posterior portions of root and crown. Wax applied to the root and crown at once holds the crown and pivot in proper relative position and gives an impression of the root end. The whole is withdrawn, and so invested in plaster that the crown,

peg and wax may be removed, and the crown be capable of accurate replacement on the model. The hole in the root and root model are now properly drilled by the same drill to receive a gold wire pivot, the latter being long enough to project above the root into the crown, and being smaller than the holes in both root and crown to allow of vulcanite enwrapping it within these spaces. Now the hole in the root model is packed with vulcanite gum, the gold pivot heated and pushed through the gum to its place, the hole in the crown also packed, and the crown forced to its position on the model over the projecting end of the gold pivot. More gum is packed in the palatal groove between root and crown, the whole flasked and vulcanized, and the finished crown forced to its place on the root, a few folds of gold foil being interposed to fill the joint tightly.

"Dr. Richardson also made vulcanite tubes for pivot sockets, to replace those of gold commonly used, by vulcanizing a layer of gum around a gold wire, which should afterward form the pivot. The wire, being wrapped in a single layer of tin foil, was readily drawn from the tube after vulcanizing, the tin being removed with muriatic acid. A proper length of the vulcanite tube was inserted in the root, either by force and a tight fit or by aid of plastic cements, and the pivot, vulcanized to a porcelain crown, was made to take up the extra space in the tube caused by the removal of the tin foil by bending, or by splitting and springing it open."

Also, Dr. H. C. Register's variation of this method, which "is to use an ordinary plain rubber tooth, and form its palatal contour with vulcanite. Through this a hole is drilled in line with that in the root, the latter being filled with hickory wood. The crown now being held in position, a drill is passed through the hole in the vulcanite into the wood in the root, and a gold screw pivot is passed through the crown into the wood root socket, holding the two firmly together. The details need no further description."

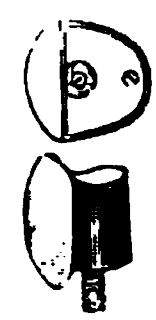
A method of pivoting a bicuspid is suggested by Dr. Bishop and described as follows by Dr. Dexter: "The root being a first bicuspid, both canals were opened, and a thin wire set loosely in each, the projecting ends being bent together like a staple over the root face. Gutta-percha was then packed upon the root face, around and under the wire staple. A plain rubber tooth was now ground to fit, and held in place while the gutta-percha was continued over its pins and shaped to contour.

"The whole was now removed together, invested, vulcanite gum substituted for the gutta-percha, and vulcanized. The tooth was set in place with plastics in the canals around the pins.

"This method appears to have much value for certain cases. Variations of it may be noted; for instance, using oxyphosphate, oxychloride, or fossiline, in place of the gutta-percha, and leaving the tooth in place, for a temporary purpose, instead of removing and vulcanizing. Also, using heavier wires of platinum and iridium alloy for the pivots, and springing them apart, after vulcanizing, so as to obtain their spring pressure in maintaining the tooth in place."

Banded or Ferruled Pivot Teeth.—Dr. W. H. Dwinelle, in the *American Journal of Dental Science*, April, 1855, was the first to suggest the banded or ferruled pivot tooth in connection with crystal gold, for restoring lost or fractured crowns. Fig. 654 represents the shape or mould into which crystal gold is packed, a plate tooth being first backed with gold, to which is soldered a band. The tooth is fastened to the root by a screw passing through a horizontal plate at the base of the backing into the dentine, and a somewhat larger screw having been placed and secured in the pulp canal, with the free end projecting into the cap on the crown, gold is built around this end and the cap filled.

FIG. 654.

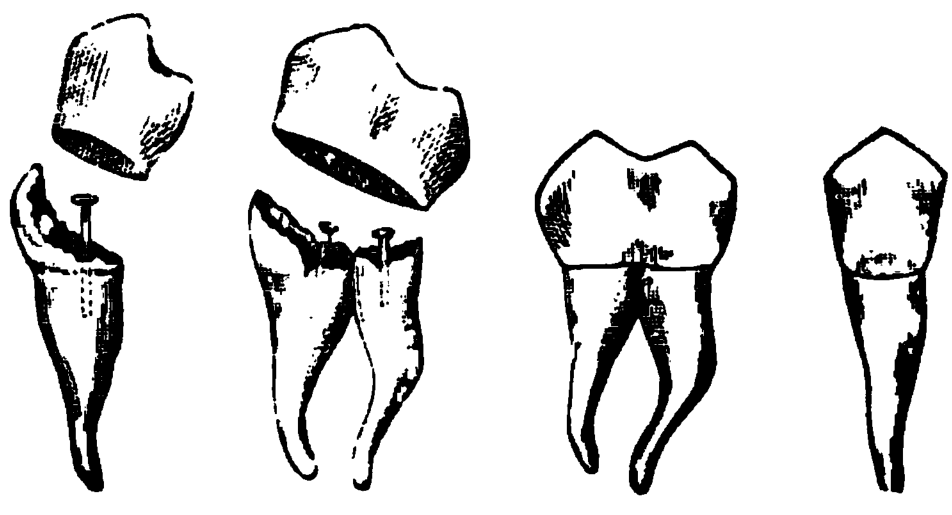


What may be more properly termed a "cap crown" than a pivot tooth was suggested by Dr. Wm. N. Morrison in the *Missouri Dental Journal*, May, 1869. No screws or pivots are used in this method, but a cap of gold is made in the form of a tooth crown by being swaged on a model or die of a natural tooth, its sides encircling the root, and extending under the gum to the edge of the alveolar process. A bar is soldered across the inside of the cap to afford a support for the oxychloride of zinc (the oxyphosphate will answer also). The root is then prepared for the reception of the cap, which is filled with the zinc preparation and pressed into place on the root. Dr. B. Beers, in 1873, suggested a method of forming a gold crown from a flat strip of gold by stamping it in the centre on a block of lead with a punch. The gold is then annealed, and the two ends bent around the tooth (the stamped surface representing the labial surface of a front tooth), and these ends soldered together. The "bite" is then adjusted by means of a half-round file, so that the tooth articulates properly with its antagonists. A thick flat piece of gold is then bent to suit the form of tooth required and soldered on the top of the gold crown, which is fastened to the root by inserting headed gold screws into the canal and then filling the cap with oxychloride of zinc, when it is forced over the root to its proper place. Fig. 655 represents Dr. Beers' crowns and method of attachment to the roots of teeth.

Dr. E. S. Talbot has improved upon the method of Dr. Beers by

a band fitted to the root and extending to the alveolus, across the inside of which a partition or floor of gold is soldered. In this floor holes are made opposite the pulp canals underneath. Wires are loosely inserted in these canals, and the space in the band beneath the floor is filled with gutta-percha or one of the zinc preparations,

FIG. 655.



and the band or collars forced into position on the root, the wires projecting through the holes in the floor. After the gutta-percha or cement has become hard, the wires are drawn out, and headed screws are substituted, which fasten the band or crown to the root. The work is completed by filling the band with gold or by swaging

FIG. 656.

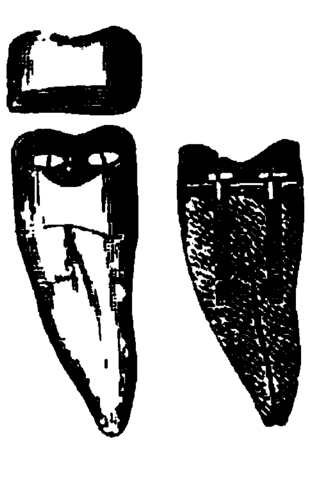


FIG. 657.

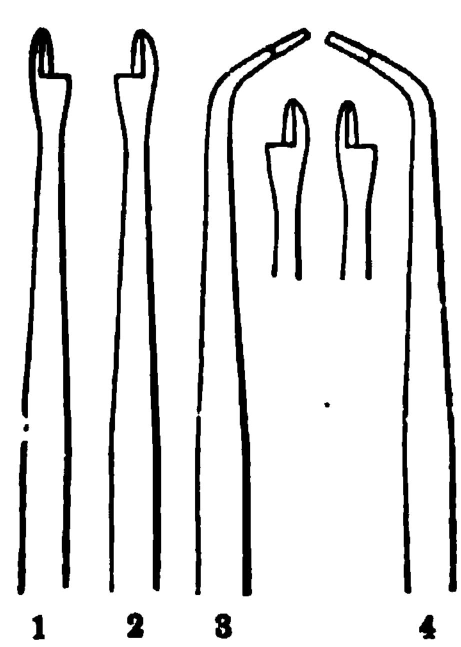
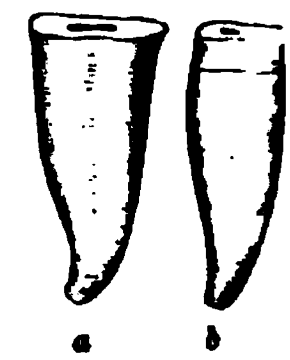


FIG. 658.



a gold crown or cap, which is slipped over or within the edge of the band encircling the root, the cap being previously filled with cement.

Fig. 656 represents Dr. Talbot's method.

Fig. 657 represents root trimmers or reducers, suggested by Dr. R. W. Starr. They are intended for trimming the edges or reducing the diameters of roots over which collars are to be placed. The shoulder keeps the instrument on the root and limits the penetration of the spur, which, by its knife edge, scrapes the side of the

root (Fig. 658 *a*), so that it may easily and quickly be given the shape of Fig. 658 *b*, or any similar form. They are made right and left; the straight pair (Nos. 1 and 2) for use on the superior roots anterior to the molars, and the curved pair (Nos. 3 and 4) for use in all the other natural roots.

Dr. C. M. Richmond's method of making what are known as the "Richmond Crowns" is as follows: This crown consists of a close-fitting band or ferrule of coin gold plate, to which a cap or surface, corresponding to the grinding surface of the class of tooth it is designed to crown, is soldered. The root is prepared by making the exposed surface flat, by means of the file or corundum disk. A strip of gold plate, about No. 27 American gauge, is then cut, of such a width as will extend from the alveolar process to a height sufficient to give the proper length of gold crown. To determine the proper width of the strip or ferrule, a pattern of tin or sheet lead, adapted to the tooth, may be used. The strip of gold plate is then bent with the pliers and filed to the proper form, and the overlapping ends soldered together, the ferrule being made slightly smaller than the root it is to encircle, so as to secure a tight fit. After the band or ferrule is completed, it is capped by a piece of plate large enough to cover the crown end, and the two soldered together, and properly finished by smoothing the sharp edges with a file and burnisher. The cap or crown is then adapted to the festooned margin of the gum and septa by filing the approximal edges concave. The margin of the gold crown, where it comes in contact with the neck of the root, is slightly beveled from the outside, in order to make a thin edge which will adapt itself to the surface of the neck under the pressure necessary to force the crown to its place on the root. The crown is then forced over the root, and the position of the artificial cusps yet to be made determined by the antagonism of the opposing teeth. Small, flattened buttons, made by melting scraps of plate and slightly flattening them by blows with a hammer, are soldered on the grinding surface of the gold crown, which is filled and invested during the soldering process with moistened sand, to which is added a little plaster. After thus attaching the cusps and contouring the grinding surface, the gold crown is ready to be adjusted to the root. A small hole is first drilled through the side or top of the crown, to allow the surplus cement, by which the crown is secured, to escape. The concavity of the crown is then filled with either the oxychloride or oxyphosphate of zinc, mixed somewhat thinner than for a temporary filling, and the crown forced over the root and the patient directed to bite upon it, in order to secure the proper occlusion of the teeth. The crown

is then firmly held in place until the cement has hardened, when the small hole through which the surplus has escaped can be filled with gold. Any slight defect in the articulation can be remedied by grinding with corundum points.

The method of Dr. H. W. F. Buttner is a combination of the ferrule, or band encircling the root, and a central pivot, and is described as follows by Dr. J. E. Dexter:—

"A special set of instruments is used in this process. Those for preparing the root are drills, reamers, and trephines (Fig. 659 *b c d*). The drill bores out the root canal. The reamer cuts the face of the root level, being guided by a central pin. The trephine turns the neck truly cylindrical for a certain distance up or down its sides being also guided by a centre pin. The root, thus prepared, is shown in Fig. 660. The drill, reamer, and trephine are in various and exactly corresponding sizes.

"A steel wire is now placed in the root, projecting half an inch. An impression is now taken, the wire projecting through it, a cup with an opening over the root being used for that purpose. The

FIG. 659.

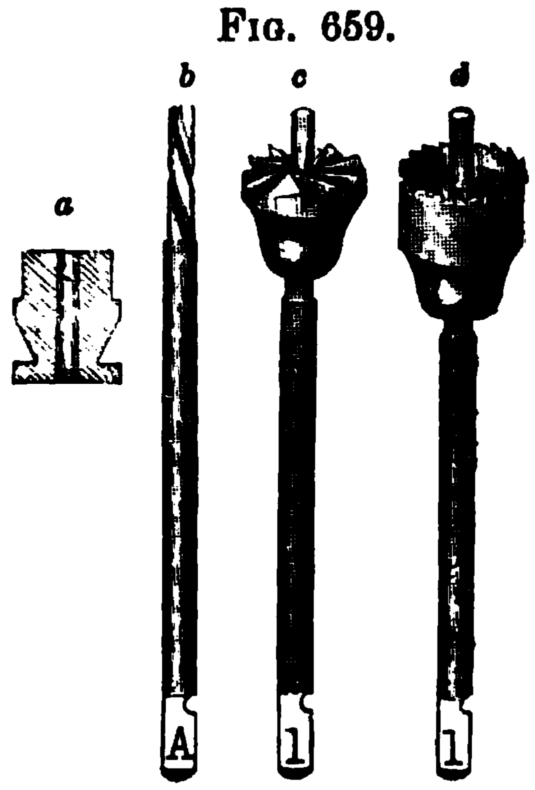


FIG. 660.

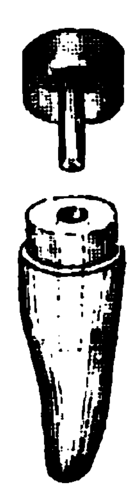
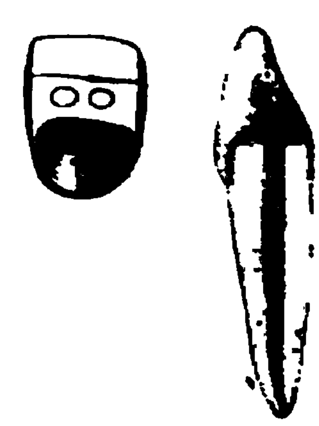


FIG. 661.



wire is withdrawn carefully before removal of the impression from the mouth, but is afterward replaced. Over it, on the impression, is now slipped that one of a set of brass root models (Fig. 659 *a*) which corresponds to a drill and trephine used, and the model is then made, and holds the brass root model in its place, with the wire projecting. The latter is now removed, and plaster cut from around the root model to a depth sufficient to accommodate the cap which is to follow. This is of gold, struck out of the solid, on that one of the accompanying steel dies which accords with the trephine and root model used. It also has a central pin, to correspond with the drill which enlarged the root canal (Fig. 660).

This cap is set on the root model, and a plain plate tooth, ground hollow on the inner surface, to cover the outer wall of the gold cap, is backed, and soldered in place on the cap—of course, after removal from the brass root model—the solder forming the palatal contour. The whole is now polished, placed on the root, and driven home with a mallet (Fig. 661).

"The perfectly accurate fitting of this operation is secured, beyond cavil, by the set of drills, reamers, trephines, dies and root models with which it is performed. Probably—indeed, almost certainly—this is the *strongest* method of attachment of artificial crowns to natural roots which can be devised. Indeed, the only thing breakable about any given case of this method seems to be the porcelain crown or face. The end and interior of the root, also, are absolutely preserved from moisture for, at least, a very long time."

Another method of forming banded root-crowns is described as follows by Dr. C. S. W. Baldwin: * "Select a Logan crown slightly shorter than would be used for setting without a ferrule. Countersink and prepare the inside of a root as for a Bonwill or any ordinary crown. If the outside of the root at the margin of the gum presents an irregular surface, then with Dr. Walter Starr's reducers (Fig. 657) shape it to such a size that the ferrule may be perfectly adapted to all parts. Take an impression, and produce in zinc or Babbitt's metal a die, to form which take a plaster model of the root-end, an eighth of an inch long, and shellac it to the point of a cone, which can be easily made by turning down a large spool, thus making the deep mould in sand into which the metal is poured. With this die strike the gold (22-carat, No. 30 gauge, is most commonly in use), laid upon soft lead. A few blows will produce a seamless and perfectly-fitting cover and ferrule. After trimming this to fit the festoon of the gum, drill in it from the lower side a hole for the pin of the crown, leaving the ragged edge produced by the drill. Then fill the countersunk portion in the porcelain crown with oxyphosphate of zinc, and with the gold ferrule or cap in place, adjust the crown as you would wish it when completed. When the oxyphosphate is hard, you will find the ragged edge on the upper side of the cover will materially aid in removing and keeping the cap where it belongs. Unite the cover to the platinum pin in the crown with a small amount of soft solder—tin and lead—using muriate of zinc as a flux, a few blasts from the blowpipe being all the heat required. Then fill the root with oxyphosphate and firmly press to place. These caps might be

* *Dental Cosmos*, vol. xxviii.

made up at leisure, providing a few variations for double and single rooted teeth. When a case is met that you cannot fit from your stock, choose a cap larger than the end of the root, and with a single clip of the shears cut to the centre of the cap, and with pliers spring together, lapping the edges until the size required is obtained. Solder with gold solder by holding over the spirit-lamp, and proceed as before.

"Fig. 662 shows a root, cover, and Logan crown ready to be assembled for the soldering of the crown-pin to the cover; Fig. 663 shows

FIG. 662.

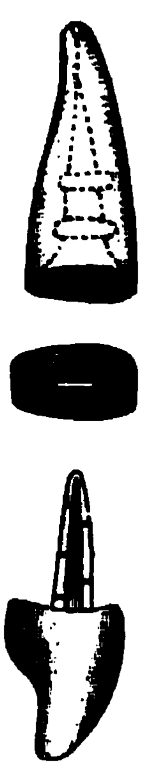


FIG. 663.

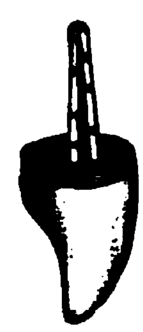


FIG. 664.

the cap cemented and soldered to the crown, and Fig. 664 the completely crowned root."

Dr. H. C. Merriam describes a new form of artificial crowns as follows:—*

"We need a crown that can be ground on its sides as well as against the root, with a straight hole through it, similar to that of the English tube teeth, excepting that the hole should come out at a greater distance from the cutting edge in the incisors and cuspids. After the crown is ground, to place the hole through, it may be formed as we desire with a copper drill and corundum, or with hard-rubber points dipped in corundum.

"There are now made, for use in machine-shops, wheels the corundum of which is united with a flux, and baked at a temperature of nearly three thousand degrees. These wheels hold a true edge, and when made small enough will be a great step in advance of what we have. I have had small points made in this way, with

* *Dental Cosmos*, January, 1887.

which I can grind out a crown to any of the forms illustrated in Fig. 665.

"I now show you some of the different varieties that can be made by grinding the crown just referred to (Fig. 666), the advantages of

Fig. 665.

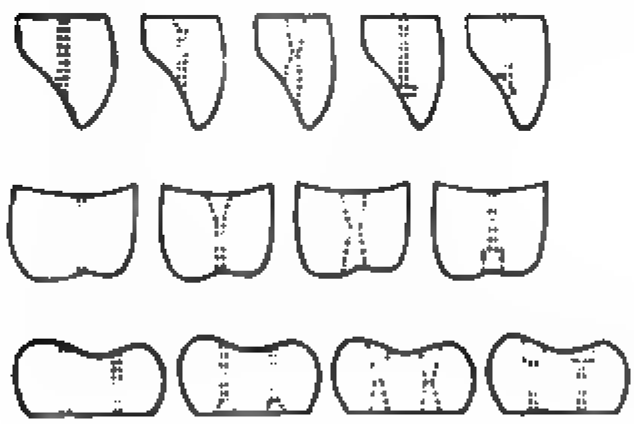


Fig. 666.

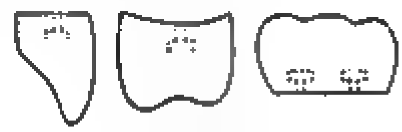
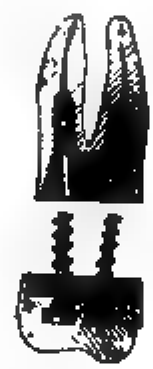


Fig. 667.



which have already been stated. With these crowns it is expected that dowels will be used, set in either cement or gutta-percha.

"We will now pass to forms which are to be secured by metal bands fitted either to the root or to the crown itself (the strongest, of course, being held at their periphery), and I will detail my method of applying the same, for it enables me to avoid the trouble and delay of investing or soldering. For these the crowns given in Fig. 665 may be used, as well as those shown in Fig. 666.

"The band is fitted to the root, and the crown ground into the band after proper occlusion with its antagonist has been obtained. If a molar, a fine groove is ground around it, and the band, after being corrugated on its inner surface with a small lining burr, is placed on a lead anvil and the tooth driven into it, thus partially securing the advantage of union by gomphosis. The common glass stopper is a good illustration of how little more than its fit would be required to retain it firmly in place. For this little I have drawn on the tube-teeth workers of England. A few small pieces of sulphur are then placed inside the band, and all held over a small flame until the sulphur melts and flows into the groove between the band and the crown. Zinc phosphate may be used before the crown is forced in, or some flux—borax, for instance, which melts at a low temperature, though this would probably require investing. We then have a crown which, if a molar, I do not fear to attach with gutta-percha without dowels; but others may not have this confidence, and dowels may either be put into the roots or set

in the crown with cement, and afterward secured to their places in the root as usual (Fig. 667). It is evident that if cement is strong enough to hold a dowel in the root it must be equally serviceable in securing the crown to the dowel. Some like the hardest way best. These may fit a fine platinum or pure gold wire into the

FIG. 668.

FIG 669.

FIG. 670.

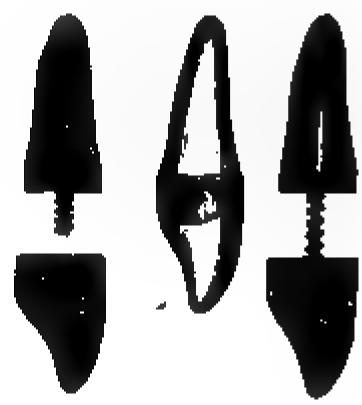
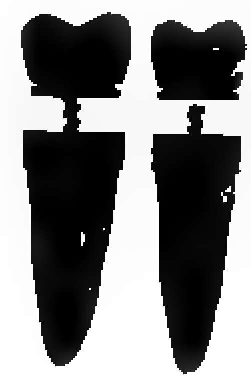


FIG. 671.

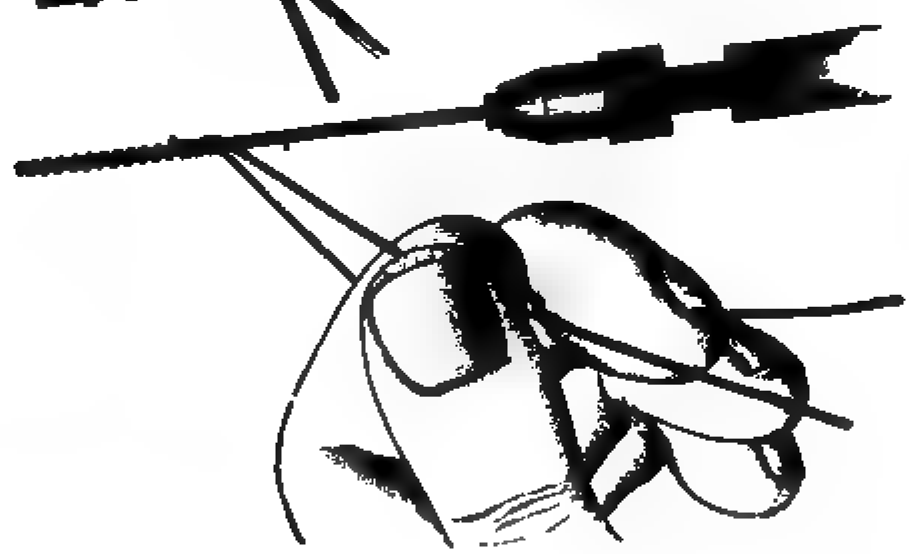


groove around the crown (Fig. 668). Drive in as before; invest and solder (Fig. 669). A gold amalgam may be used, such as was employed by old plate-workers for banding a plate over the teeth. I have not tried this, but suggest it as of possible use, the dowels being

FIG. 672.

FIG. 674.

FIG. 673



put in as before. For the incisors the groove should not run around the anterior face of the crown, and I have not soldered these teeth in (Fig. 670). I have entire confidence in any form for the incisors and bicuspids where the root is well banded, the dowel put into the centre, and the crown forced to place in gutta-percha (Fig. 671); while for the molars, if quite short, I do not care for the dowels

You will notice that this method does away with much of the showing of gold in molars, where such a result is desired (Fig. 672).

"When cohesive gold was first used we thought nothing could be more beautiful—the more conspicuous the better—but we gradually learned that the perfection of art was to conceal art. So it is with tooth-crowns, and we shall learn soon to omit great backings, etc., wherever possible; not only because they are conspicuous, but because a tooth backed up by any substance is no longer translucent.

"I will present one more form for molars, and although it shows more gold than any of the others, it is perhaps the strongest of all. The band is made full width down to occlusion, and any large, strong tooth is ground to fit the space to be filled in the arch. This is driven into the band so as to be even with its edge; cemented with sulphur as before, and I think we have a crown that is made for all time (Fig. 673).

"*Setting.*—I first varnish the band inside with Canada balsam dissolved in ether; then fill the crown with gutta-percha and crowd it up against the root several times, to get an impression. When sure that I have the right amount of gutta-percha, I place the dowels in the root (if I am to use them); heat the crown; dip it into cajeput or any essential oil, and crowd it to place. The dowels I fit in the same way, wrapping them with gutta-percha and working up and down in the root until I get the impression, before the final forcing to place. I thus have the advantage of the dowel and hard centre of gutta-percha to act as a plunger, and the soft, semi-dissolved gutta-percha comes back on the outside of the mass, forming, I think, the tightest root filling known. I fill roots in this way with gutta-percha points when I do not use a dowel. The dowels used are made by wrapping a piece of platinum and iridium wire with about one-third of a sheet of gold foil, which is melted on and the combination made true by being drawn once through a wire-gauge. A piece of piano wire is then wound around it three or four times, to serve as a guide, and a fine platinum wire, previously drawn square, is caught and turned through the wire guide a few times, when the winding may either be finished by hand, or the end, after being started, may be placed in a lathe-chuck and wound up at once (Fig. 674). A piece of gold foil is then wrapped around the whole and the fine wire soldered on. A dowel made in this manner is not strained by having its thread cut, and the thread, being square and coarse or fine, as you wish, is strong and possesses plenty of grip.

"Should these forms prove as valuable as I hope, those at a dis-

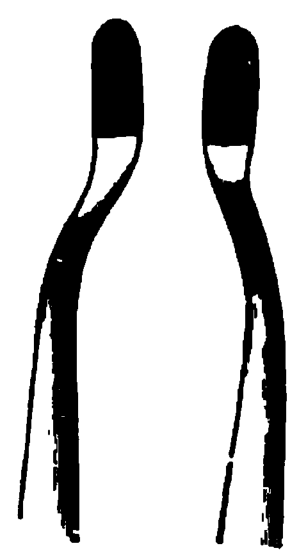
tance from the cities, without gas, will find that the labor of crowning roots has been much lessened.

"When a root has broken off far under the gum it should be filled with gutta-percha, and a temporary plate worn—if the loss be in the front of the mouth—until the root works down, when it may be crowned and the plate given up.

"In preparing roots after a large portion of the crown is broken away, I enlarge the pulp-chamber with a large, round burr, and, when even with the gum, follow with the revolving saw here shown (Fig. 675). With this saw I often cut off the remnants of a crown from the inside without wounding the gum or drawing a drop of

FIG. 675.

FIG. 676.



blood, and am saved the unpleasantness of running a stump corundum wheel in the mouth. The outside of the root can sometimes be formed with the instrument here shown (Fig. 676)."

Fig. 677 represents porcelain cusp-crowns.

These porcelain cusps are designed for use with a gold band representing the body of the tooth. The band or collar is first fitted to the suitably prepared root, and the cusp-crown is then fitted in the collar. The collar is then filled with gutta-percha, cement, or amalgam, and the crown pressed into place. 1 shows in section a molar root, collar, and cusp-crown. 2 shows the same mounted.

In cases where it is desirable to show as little of the gold collar as possible, the forms indicated in 3 and 4 may be employed, the gold band being cut away on the buccal side, as shown in the cuts.

Dr. E. T. Starr, in the *Dental Cosmos*, describes an improved "die-plate" and "hubs" for shaping metal cap-crowns, of his own suggestion:—

"In the construction of metal cap-crowns to cover natural teeth or teeth-roots there are many methods which result in good work, but in most cases the caps do not articulate as well as they might, for the reason that means for embossing the bicuspid and molar cusps are not at hand, or available within the short time at the disposal of either the patient or the dentist. With the object of providing an easy and quick way of working under such circumstances, I have made a single

FIG. 677.

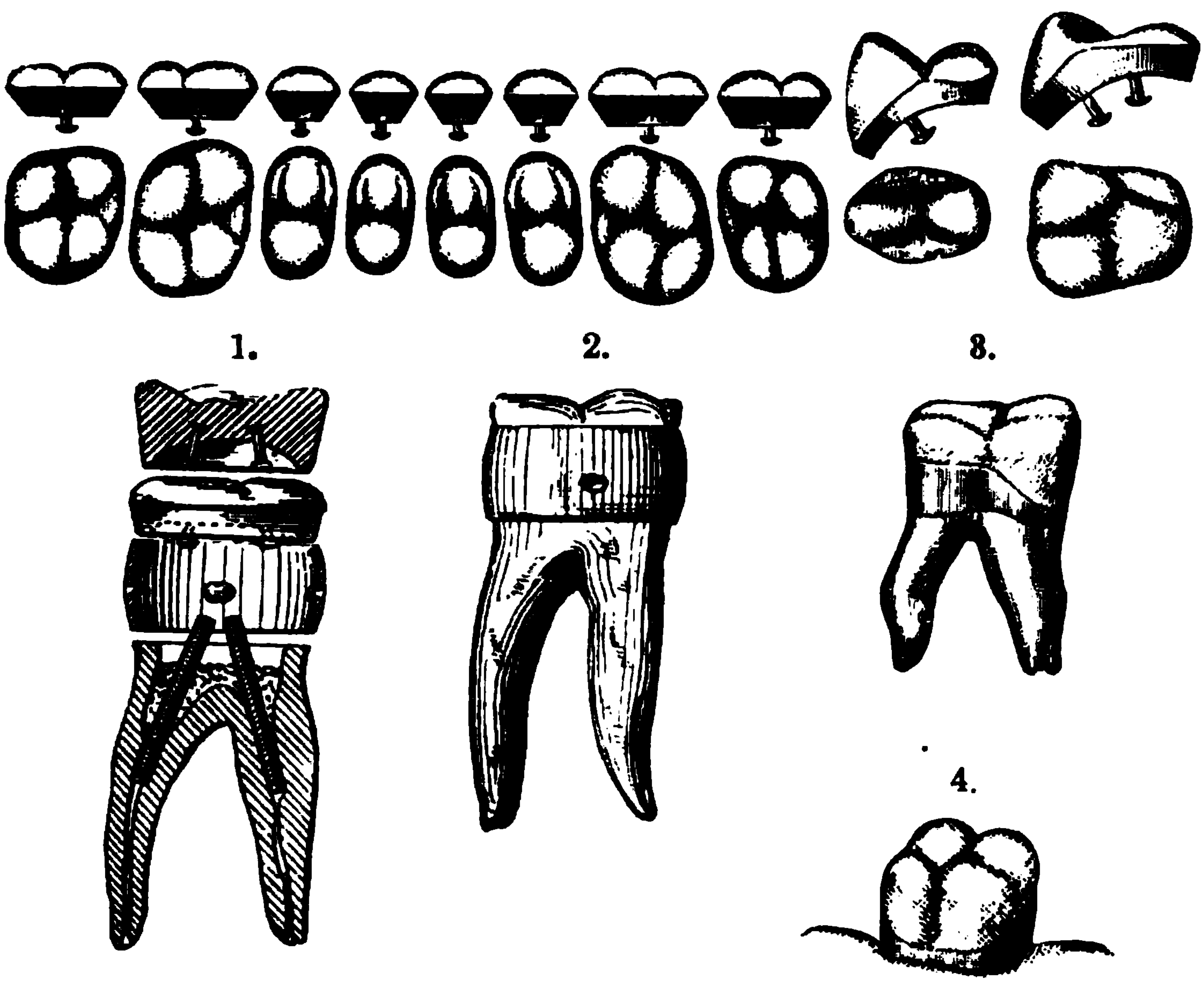


plate (Fig. 678) in which are four groups of intaglio dies representing with distinctive correctness the peculiar cusps of the upper and lower right and left bicuspids and molars. These are indicated by the Hillischer notation, so that each form may be easily identified in practice.

"The hubs A B (Fig. 679) are of the sizes shown, and are made of an alloy composed of tin one part, lead four parts, melted together. The mould C should be warmed, the melted alloy poured in every hole, and the overflow wiped off just before the metal stiffens. This will make the butts of the hubs smooth and flat. After a minute or two the mould may be reversed, the hubs shaken out, and the casting process continued until a considerable number of hubs shall have been cast.

"In Fig. 680 a molar hub is shown in place on a piece of No. 32

gold plate, which lies over the 6. (upper right first molar) die. A succession of blows on the hub, with a four-pound smooth-faced hammer, will drive the plate into the die, and at the same time

FIG. 678.

spread the hub metal from the die centre to its circumference in such a manner that the plate will be perfectly struck-up with the

FIG. 679.

C A B

least possible risk of being cracked. The flattened hub is seen in Fig. 681, which also shows at D the obverse of the struck-up hub,

and at E the cameo of the struck-up plate having every cusp and depression of 6. sharply defined

"The counter-die plate (Fig. 678) is made of a very hard cast metal, which will admit of the striking up of many crown-plates by

FIG. 680.

the means and methods described, if the crown-plates be not too thick and stiff. Of course they should be annealed before they are placed over the die. In careful hands, the die-plate should give clear cusp definitions after years of use.

"For the reason that the counter-die plate is in some respects similar to a stereotype plate for printing, the struck impressions on

FIG. 681.

E D

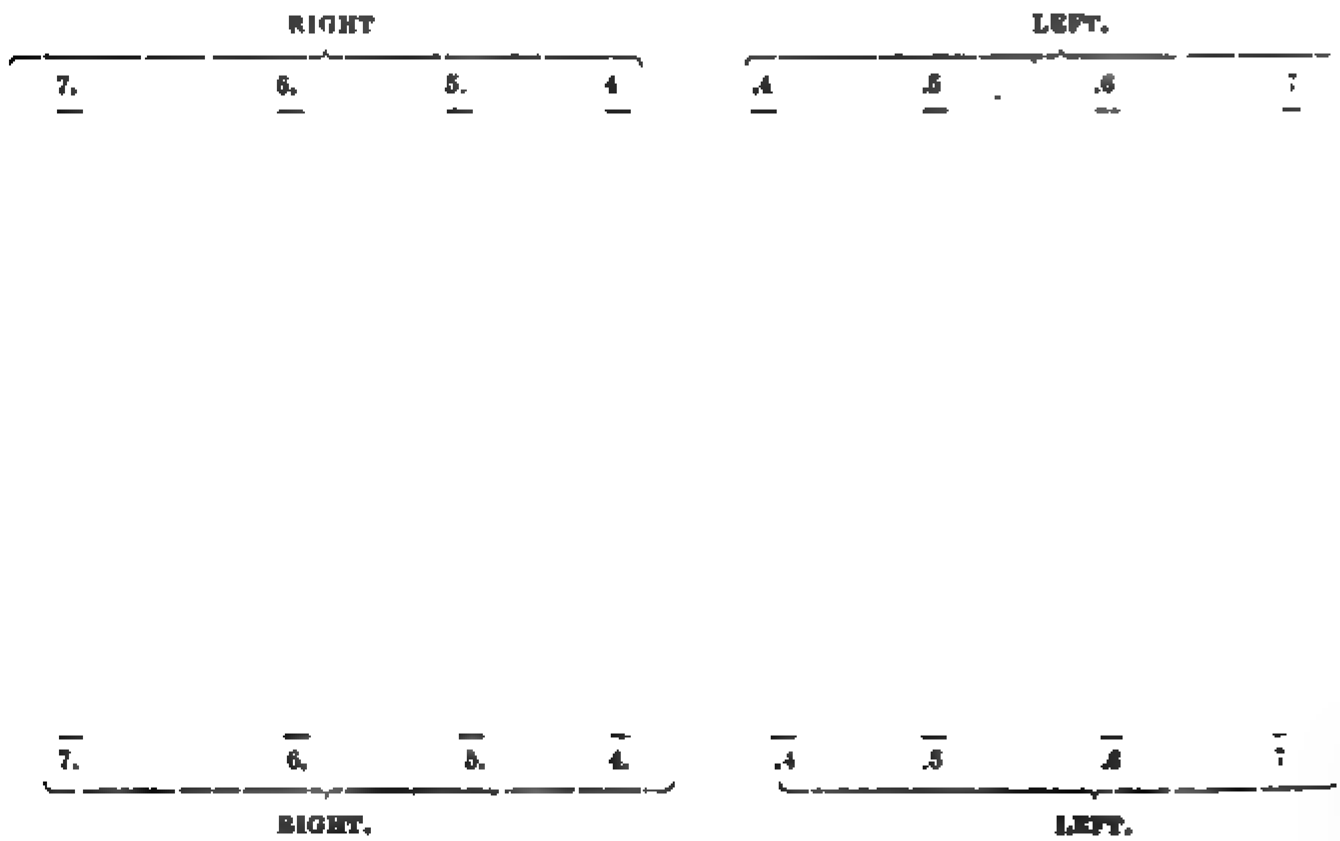
two strips of thin plate will appear as in Fig. 682, wherein their regular order is noticeable as seen from the cameo surface of the struck plates. The peculiar action of the hub in forming first the centre of the crown plate, and spreading from the centre outward, as the hub is shortened under the hammer, until the die is overspread by the plate and hub, with the result shown in Fig. 681, is an essential feature of this process for obtaining easily and quickly the superior

styles of coronal cameos shown. If a cusp or fissure should chance to crack in hubbing, a small piece of plate may be struck over it, or another crown plate be struck over the first and the two soldered together.

"The depressions in the struck plate can be partly or wholly filled with scraps of plate or solder, and the surplus plate cut away from the cameo.

"The fact is noteworthy that, by means of the Knapp blowpipe, the coronal intaglio may even be filled with melted scraps cut from the identical plate out of which the cameo was struck. The better

Fig. 682.



way, however, is to fill, say a twenty-carat cameo with eighteen-carat plate scraps. The fitting and soldering of the doubled or filled cameos to suitable collars is a simple matter, and need not be described.

"It only remains to add the statement that, by this counter die and hub process, gold, platinum, silver, or other metallic cap-crowns, having finely-formed and solid cusps for proper occlusion and resistance to wear, can be made with little trouble and in a very short time."

Artificial Crowns Attached to Natural Teeth without Plates or Clasps.—These operations are of comparatively recent date, and are generally known as "bridge work" or "grafting," which is simply an extension of artificial crowns over the spaces made by the loss of

natural teeth. The credit of first inserting artificial crowns to adjoining natural teeth, by fillings of cohesive gold foil, is due to Dr. B. J. Bing, who describes his method as follows:—

"In the case of inserting a central incisor, a cavity must be made in the palatine depression of the adjoining central, and also the lateral, and one in the approximal surface of either of these teeth, about the place where we usually find decay on these surfaces. An impression is then taken which will show these cavities, and a gum or plain plate tooth carefully fitted and backed with gold, observing the precaution of allowing a small point of the backing to extend into the approximal cavity. Two little griffes (bars) are then

Fig. 683.

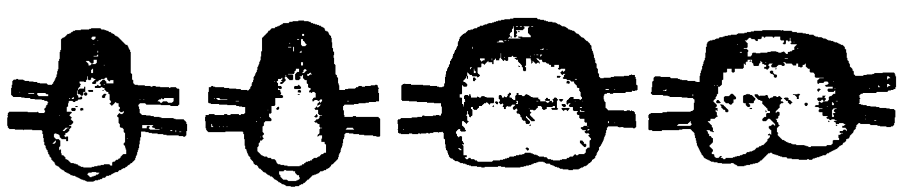


Fig. 684.

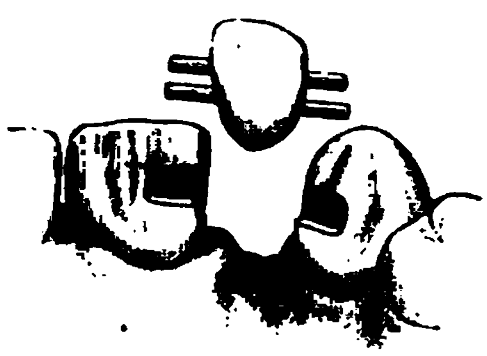


Fig. 685.

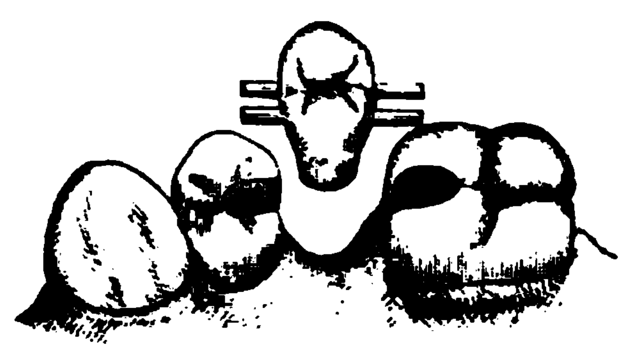


Fig. 686.

Fig. 687.

soldered to the base of the backing, the ends of which are carefully plugged into the palatine cavities with gold foil, in such a manner as will tend to draw these teeth very slightly together."

Figs. 683, 684, 685, 686, 687 represent Dr. Bing's bridge-teeth.

Fig. 683 represents porcelain crowns having two strong pins of platinum baked in each side, the pairs of pins being so placed that the tooth when fixed in position is held firmly in proper relations to the adjacent teeth. Fig. 684 shows the supporting teeth prepared to receive a lateral incisor. Fig. 686 is a face view of the same in position. Figs. 685 and 687 show the same in the case of a bicuspid crown.

These crowns may be soldered to each other, or to collars and to cap-crowns, in the construction of every form of bridge denture.

Dr. W. F. Litch has modified Dr. Bing's method, an abridged description of which, by Dr. Dexter, is as follows:—

"Supposing a left upper lateral to be inserted: Take an accurate impression of the parts (canine and central, and gum between), and make metallic dies from the model. Swage gold or platinum plates to very exactly fit the palato-approximal surfaces of the canine and central. Fit into the interspace a plain plate lateral incisor, slightly wider than the space to be filled, beveling and grinding the sides posteriorly, so that the tooth cannot be forced backward between its neighbors; the neck fitting accurately, but lightly, upon the gum. Back the tooth with gold. Place the prepared tooth and the struck plates upon a perfect model of the parts, and adjust the tooth backing accurately to the plates on each side. Cement together with shellac or other resinous cement; remove and complete the

FIG. 688.

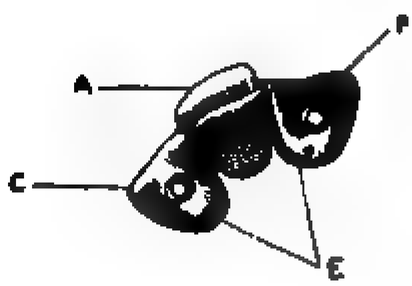


FIG. 689.

final adjustment in the mouth. Invest, and solder the tooth and plates together in their exact relative positions, observing to accumulate a large portion of solder over the joints (Fig. 688). The apparatus, if now placed in the mouth, will be found self-supporting against any force except the perpendicular; for it cannot be forced backward into the mouth, owing to the extra width of the lateral; nor forward out of the mouth, owing to the wings or plates extending over the backs of the neighboring teeth; nor upward toward the gum, owing both to the porcelain tooth resting thereon and to the converging planes of the plates or wings and the postero-approximal surfaces of the artificial tooth.

"The methods of final attachment are two, depending upon the case: 1. If one of the neighboring teeth is devitalized, attaching a pivot to the plate on that tooth and inserting it with gutta-percha, the plates themselves being covered with a film of the same substance on their dental aspects (Fig. 689). If the teeth are both alive, a modification of Bing's plan of filling, performed as follows:

"The denture being constructed as before described, and polished, drill a cavity in the centre of the palatal face of each tooth covered by the plates, slightly larger in diameter than the head of the pin in an ordinary rubber tooth, no deeper than the enamel, and undercut (Fig. 690 B). To each of these openings fit a platinum one-headed rivet, the head being very thin and perfectly flat on each side. Split the shanks of the rivets nearly to the head (Fig. 690 A). Make openings in the plates to exactly correspond with those in the teeth, and countersink them deeply on their palatal aspect. Place the gutta-percha on the dental surfaces of the plates, as described, and press the denture to its place in the mouth. When the cement is cooled and hard, remove that portion pressed into the holes in the plates and teeth, pass the rivet heads through the holes in the plates to their seats in the tooth cavities, and fill them in position with gold. When the fillings have reached the level of the tooth surfaces, spring open

FIG. 690.

FIG. 691.

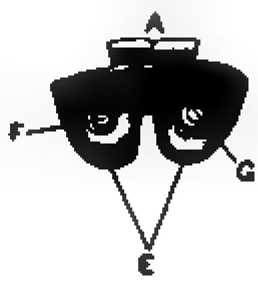


FIG. 692.

the split rivet shanks and continue packing gold around and between the separated parts and into the countersinks in the plates until flush with the plate surfaces. Cut off the surplus pivot shanks and finish (Fig. 690)."

Dr. Litch's method can also be adapted to the restoration of fractured angles of incisor teeth, as shown in Figs. 691 and 692, and which need no further description.

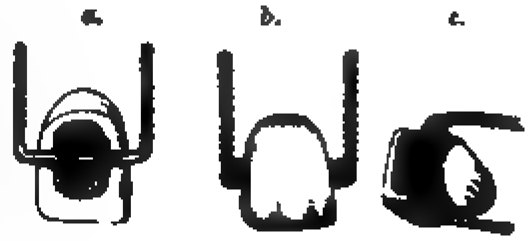
Fig. 693 represents a case of two bicuspid crowns secured to one root and two adjoining teeth.

The late Dr. M. W. Webb also modified the methods of Dr. Bing by forming an undercut groove in the porcelain crown in each side and along the cutting-edge, and filling gold foil solidly in the groove and slightly over the cutting-edge, to make the porcelain crown more secure than the platinum pins hold it, and to protect the edge from the occlusion of the lower teeth; also to build the crown into the approximal surfaces only.

Dr. Webb also described a method by which a crown without plate or clasps and where no root remains can be inserted: "After suitably forming the cavities in the proximate wall of each tooth next the space left by the loss of the one that had been extracted, a plain porcelain crown was fitted to the place and backed with gold plate. A portion of the backing extended about one and a half lines from each side of the crown for insertion in the cavities prepared in the adjoining teeth, and to these parts a gold wire was soldered to fit into the pulp-chambers of the adjoining teeth. A small gold plate was then formed to fit upon the gum, covering as much space as was taken up by the neck of the natural tooth. When the backing was riveted to the pins in the crown and this placed in position, and while the whole rested on the small plate

Fig. 693.

Fig. 694.



d.

upon the gum, the backing and plate were so secured by wax that they could be removed intact and soldered. Each extended side of the backing and the surface of the wire was barbed, so that the gold foil would the better secure the crown when filled into every part. The crown with the gold attachments being ready for insertion, oxychloride of zinc (or oxyphosphate) was placed in the pulp chambers of the adjoining teeth and the crown at once pressed to place. When the cement had hardened, a portion of it was cut away, so as to make proper anchorage for light, cohesive gold foil, which was impacted in small pieces around part of the wire and that portion of the plate extending into the cavities, and the crown was then secured."

To avoid any danger of the porcelain crown being broken from the platinum pins, Dr. Webb suggested that a groove be cut in each

side, and along the cutting-edge of this crown (Fig. 694 *d*), so that gold foil may be impacted into it by means of a fine-edged corundum disk, after a heavy backing of gold plate and the wire have been fixed in place and soldered (Fig. 695, *a*). Into this groove the wire to connect the artificial crown with the natural teeth is to be placed (Fig. 694 *a*). When the operation of contouring the palatal surface of the crown with gold foil is completed, the case presents the appearance shown by Fig. 696.

Dr. Webb also made use of a stout wire (No. 13), with a screw thread cut upon one end, for insertion into a devitalized tooth, and

FIG. 695.

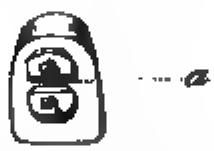


FIG. 697.

FIG. 696.

bent to receive the porcelain crown which was soldered to its free end, the wire being secured in place in the natural tooth by filling around it with gold foil (Fig. 697).

Figs. 698, 699, and 700 show an extensive operation performed by Dr. M. W. Webb, in which he made use of gold wire (No. 13) for bridging a lateral incisor, the natural tooth having been lost, and also the crown of the left cuspid, and disintegration having taken place in many of the teeth, and the front teeth abraded to the dentine. Fig. 698 shows the cases as prepared for filling, with the artificial crown attached to the gold wire in position, and gold screws inserted in the pulp-chambers of the cuspid and bicuspid teeth.

Fig. 699 shows the labial contour of each crown after the lost portions were restored with gold foil. Fig. 700 shows the finished case.

What is known as the "mandrel system" of bridge-denture is described as follows:—*

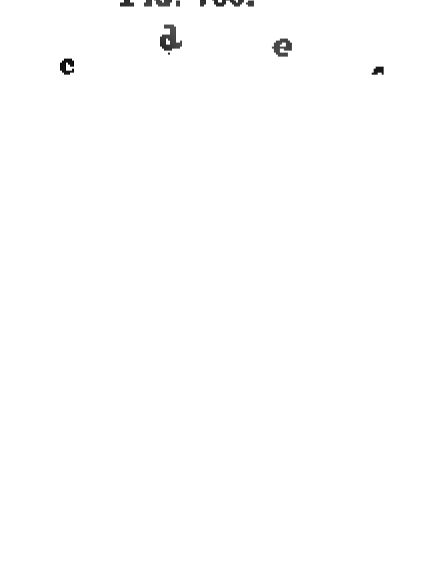
In all of the various systems of crown and bridge-work which have been brought to the attention of the dental profession, one very important point seems to have been overlooked, viz., the compara-

* *Dental Cosmos*, Aug., 1886.

FIG. 698.

FIG. 699.

FIG. 700.



Finished case—*a*, *b*, *d*, *f*, *g*, and *h*, pulpless teeth; *g*, whole crown restored with gold; *a*, *f*, and *h*, almost entire gold crowns; the teeth *b* and *d* support the gold crown faced with porcelain, *c*, and fully one-fourth of the crown of each of these is restored with gold, as is also that of *e*, the pulp of which is living.

tive conformation of the necks of different classes. The general forms of the crowns of teeth have long been well-known, but so far as we are informed no systematic classification of the shapes of the necks has heretofore been made. It would appear that such a classification ought to form the basis of any system of crown and bridge-work claiming a scientific foundation. To lay the groundwork of the system here described a large number of human teeth of the various classes were secured, their crowns cut off, and the shapes of the stumps accurately determined; thereby developing the fact that, no matter how great differences may exist in the apparent shapes of the crowns of individual teeth of a given class, there is a remarkable uniformity in the configuration of their necks. That is, the necks of upper cuspids, for instance, were found to have a fixed type, from which the variations were very slight as to shape, though there appeared to be no exact standard of size. So of the other classes, with the single exception of the superior molars, in which two distinct forms were found, the first being those in which the buccal roots were wider than the palatal; the second, those in which the reverse condition was found, the single palatal root being wider at its junction with the crown than the two buccal roots. The occurrence of roots of the second class being rather exceptional, the first class was accepted as the type.

The configuration of the necks of all the teeth having been determined, a set of mandrels for shaping collars to fit them was devised. The set (Fig. 701) consists of seven mandrels, six of which are double end. Their shapes are modeled upon the general typal forms of the necks of the teeth which they represent, and they are made tapering to provide for all required variations in size. The illustrations are about two-thirds actual size, the longest instruments being nine inches in length. The cross-sections show the shapes and proportionate sizes at the greatest and least diameters. The long taper permits the most minutely accurate adjustment of the collar.

No. 1 is a double-end mandrel, for superior molars, right and left; No. 2 is a single mandrel, for superior bicuspids, right and left; No. 3 is a double-end, for superior cuspids, right and left; No. 4, double-end, for superior centrals, right and left; No. 5, double-end, for inferior molars, right and left; No. 6, double-end, for the inferior centrals, laterals, cuspids, and first bicuspids, right and left; No. 7, double-end, one end for the superior lateral incisors, the other for those bicuspids in which a bifurcation of the roots, or a tendency in that direction, extends across the neck to the crown, in the form of a depression on one or both approximal surfaces.

Fig. 701.

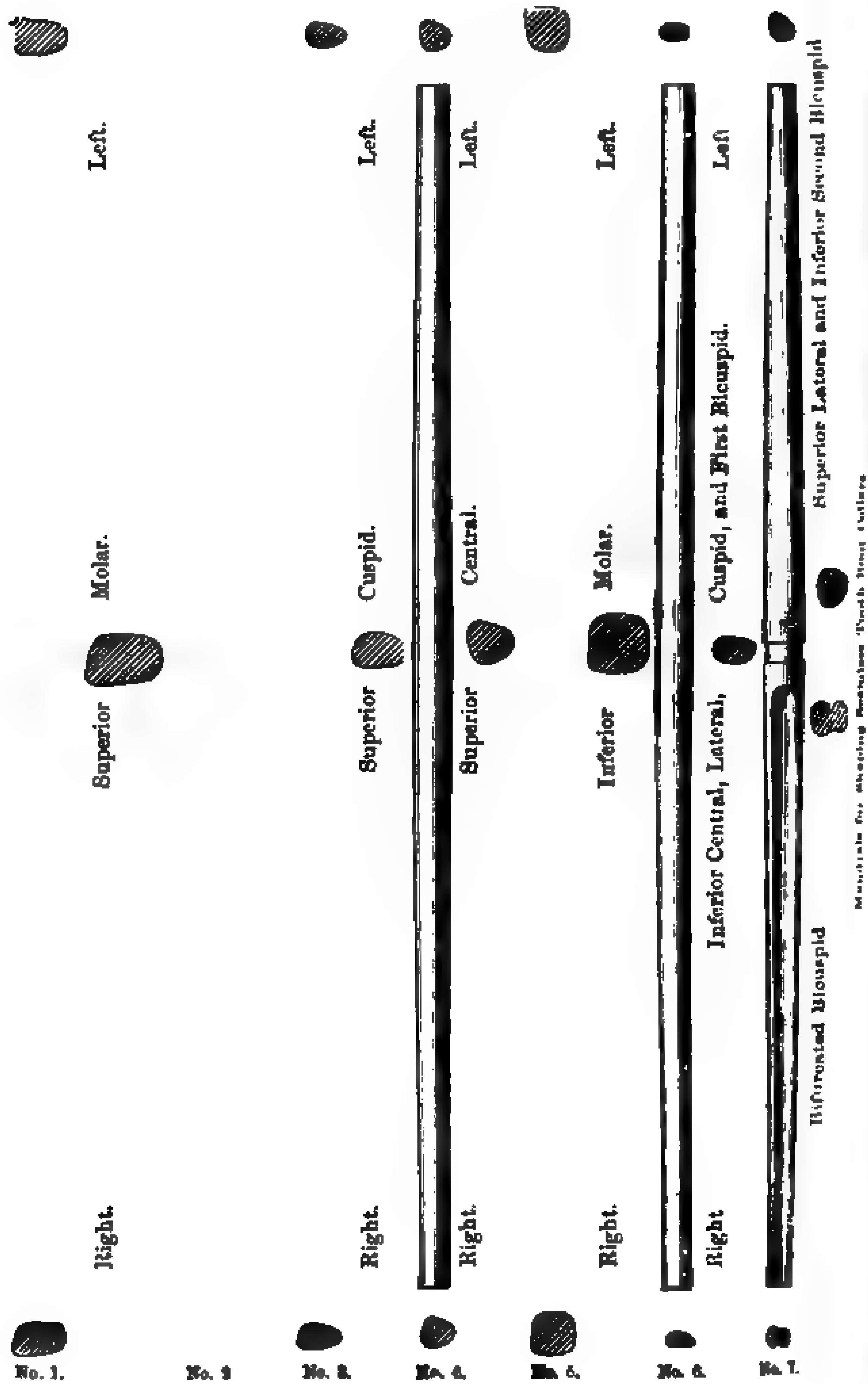
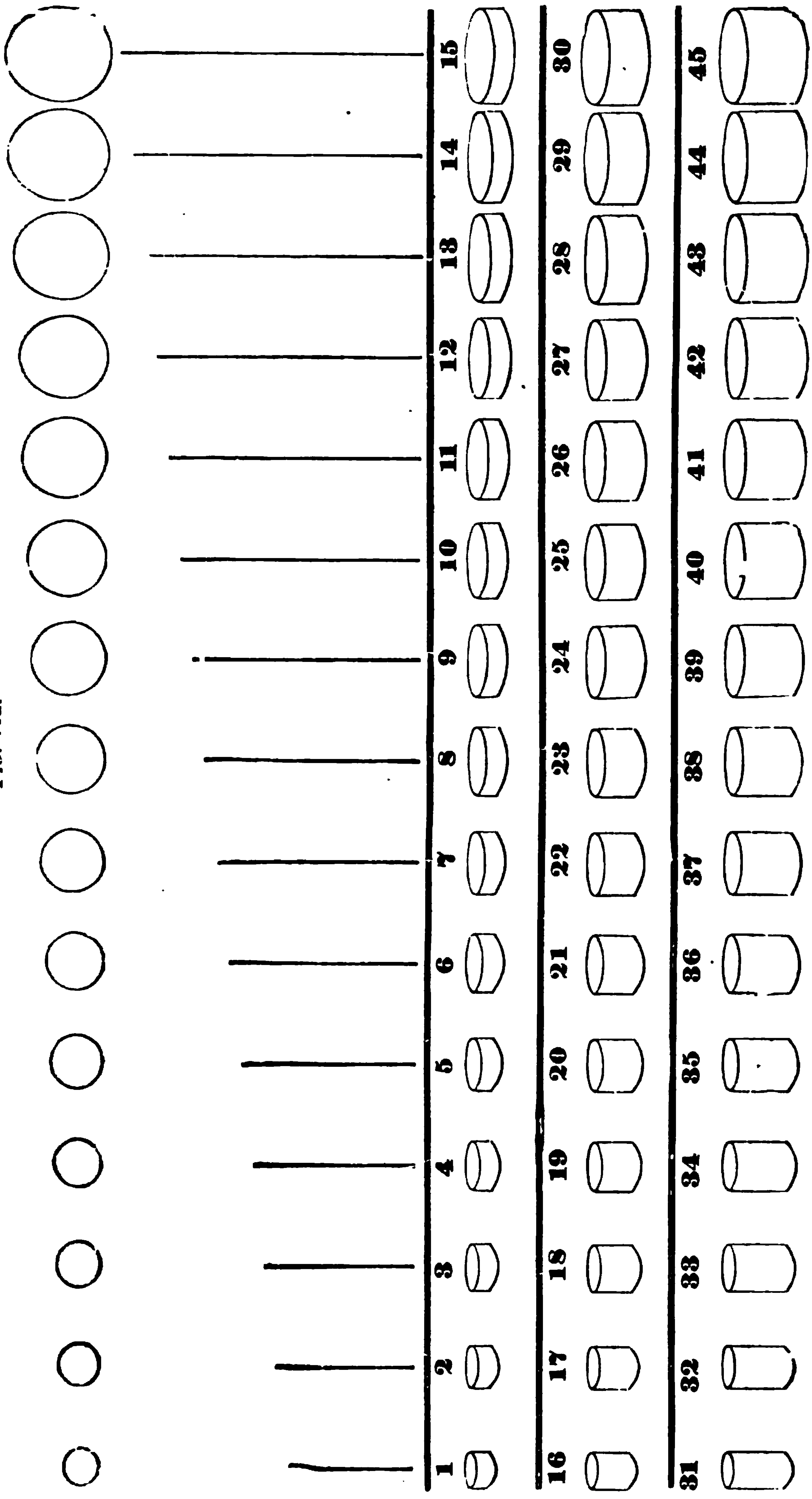

Superior Molar.
Right.
Left.
Superior Cuspid.
Right.
Left.
Superior Central.
Right.
Left.
Inferior Molar.
Right.
Left.
Inferior Central, Lateral, Cuspid, and First Bicuspid.
Right
Left
Bifurcated Bicuspid
Superior Lateral and Inferior Second Bicuspid
No. 1.
No. 2
No. 3.
No. 4.
No. 5.
No. 6.
No. 7.

Fig. 702.



Seamless Collars for Crown and Bridge-Work. (*Copyright, 1886, by the S. S. White Dental Manufacturing Co.*)

The foregoing scheme comprehends all the teeth of the permanent set except the second inferior bicuspids. The necks of these approximate those of the superior central incisors so closely in shape that it was deemed inexpedient to make a separate mandrel, as the No. 4 mandrel will serve for both.

The collars or bands are made seamless, of No. 30 (American gauge) gold plate, 22 carats fine. Fifteen sizes, each of three widths ($\frac{1}{10}$, $\frac{2}{10}$, and $\frac{3}{10}$ inch) are made (Fig. 702), which it is believed will cover all requirements. These collars, although devised as a part of the system, can be used in all methods of crown and bridge-work which require bands, and possess many advantages over any others. They are really labor-saving devices, as their use saves the time and trouble of making, and there is no danger of their coming unsoldered when the pins or the backing of the crown is being soldered; and there are no hard spots to give trouble in burnishing, as, for instance, close to the root, after the collar has been shaped and placed in position, the whole surface being uniformly soft.

The seamless collars are also especially adapted to removal or detachable bridge-work. They are so constructed that Nos. 1, 16, and 31 exactly fit into or telescope with Nos. 2, 17, and 32, and so on through the entire set, each collar fits into the series next higher; so that a root may be banded with one size and the size next larger used to form the tube for the telescoping crown. Their advantages for the construction of cap-crowns are obvious.

The other appliances specially devised for this system are, a reducing-plate or contractor, a pair of collar pliers, and a hammer.

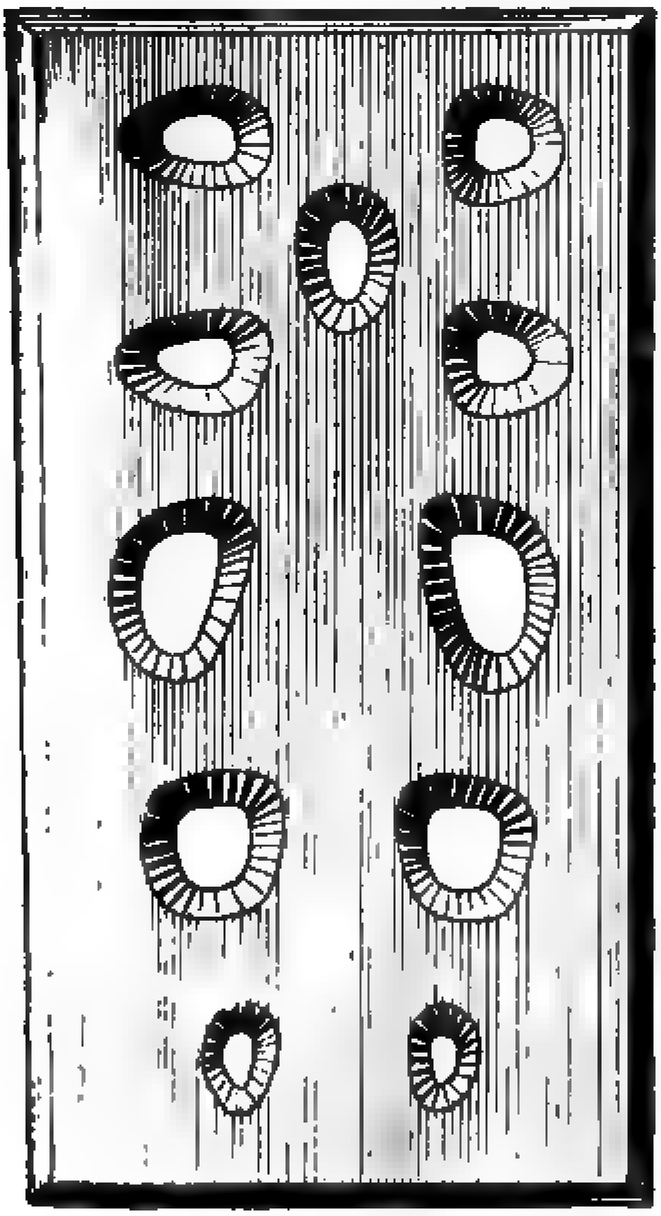
The contractor (Fig. 703) contains holes which are complementary in shape to the mandrels. The mandrels being applied to the inner circumferences of the collars, while the contractor must admit the collars themselves, the short taper of the holes in the contractor necessarily covers a somewhat greater range of size than is shown in the mandrels. With this appliance collars can be evenly and accurately reduced in size at the edges, without burring or buckling. The illustration is actual size.

The collar pliers (Fig. 704) are for contouring the collars to shape, one beak being made convex and the other concave to correspond. With this appliance the slightest changes required in the contour of the collars are easily made. About a half inch from the extremity of the concave beak a small bar of flat steel is attached to it by means of a screw. The free end of the bar has a minute projection upon one face, the other being reinforced to fit into the concavity of the beak. In the centre of the face of the convex beak

is a depression, into which the projection on the steel bar strikes, making a very efficient punch for forming guards or stops to prevent the collars from being forced too far under the gum. The depression in the convex beak being slightly larger than the projection, or punch,

Fig. 704.

Fig. 703.



the metal is not cut through, but merely raised on the side opposite to the punch. The punch attachment, being pivoted, can be swung to one side when not in use.

Fig. 705 is a mallet or hammer, with steel face and horn peen. The handle is 9 inches long.

One of the appliances required is a lead anvil, which, being only a piece of soft lead, say 2 x 3 inches and an inch thick, is not illustrated. The female die of an ordinary case will answer very well.

To illustrate the uses of these appliances, take a case in which two inferior bicuspids of the left side are missing, and the crowns of the cuspid and first molar so badly decayed that the probabilities are that they will soon fall victims to the forceps. The old-time way would have been to extract the molar and cuspids, and make a partial plate. Examination, however, shows that the roots of these two teeth are in good condition, affording an excellent opportunity for the construction of a piece of bridge-work.

With a corundum point or rotary file, cut off the remaining portions of the crowns level with the gum margins. Prepare the roots in any of the well-known ways, thoroughly cleansing the apical portions and filling them with whatever material is desired, being careful only that the work is well done. For the better retention of the filling material to be placed in the pulp-chamber, retaining-grooves can be made or retaining-posts inserted. Take a piece of binding-wire (No. 26, American gauge), say 2½ inches long, pass it around the neck of the molar stump, cross the free ends, and, holding the wire in place with one finger, twist the ends with a pair of flat-nose pliers until the wire clasps the neck closely at every point (Fig. 706). Where there are irregularities in the contour of the tooth, it is necessary to press the wire into them with an approximal burnisher. It is obvious that the ring thus formed will show the exact size and shape of the neck of the tooth. Remove the ring carefully, lay it on the lead anvil, put over it a piece of flat metal, and with a smart blow from a hammer drive the wire into the lead (Fig. 707). Upon removing the wire an exact impression of the ring will be left in the lead anvil. (This part of the work, as, indeed, all others, should be done carefully as described. The wire ring may be driven into the lead by a direct blow of the hammer face, but the blow might not strike equally, and the interposition of the flat metal held level insures an even impression. A piece of an old file is best, as the file-cuts keep the wire from slipping.)

Next, cut the wire ring at the lap, straighten out the wire, and select a suitable collar by comparing the length of the wire with the straight lines in the diagram (Fig. 702) which show the inside diameters of the various sizes. Should none of these correspond exactly, take preferably the next size smaller. It will be remembered that the collars are No. 30 in thickness, while the wire with which the conformation is secured is No. 26. This difference permits the collar when contoured to shape to enter the lead impression readily, a decided advantage in fitting. Having selected the collar, fit it to mandrel No. 5, with the peen of the hammer, holding it upon the lead anvil, and using a slight pushing force to help in stretching

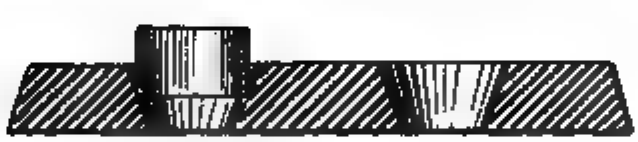
Fig. 705.

Fig. 706.

Fig. 707.

Fig. 708.

Fig. 709.



and forming it (Fig. 708). Having driven the collar to form, remove it from the mandrel and try in the lead impression. If it does not fit exactly, return it to the mandrel and stretch it a little, when it will usually fit perfectly, as the mandrels have been designed carefully to the average shapes which obtain in the great majority of tooth-necks. In the exceptional cases where the collar does not fit it can be readily contoured to the exact shape with a pair of flat-nose pliers. Of course, if it fits the impression in the lead, it will fit the neck of the tooth, always provided the measurement and the impression have been carefully made.

If the collar or band has been accidentally stretched too much, or if for any reason when brought to shape it is too large, its root end can easily be reduced to the proper size by the use of the contractor. Place the edge of the collar which is to fit the root in the proper hole; hold it level with a piece of file as in taking the lead impression of the ring, and tapping lightly on the file drive the collar into the plate (Fig. 709) until the proper reduction is made. The collar is next "festooned" to correspond to the shape of the maxillary ridge. Lay it, gum edge up, on the lead anvil, and with the piece of flat file and the hammer drive it into the lead. A few cuts with a fine half-round file across the approximal diameter will conform the edges to the surface of the ridge (Fig. 710). Then place the collar in position, and, having ascertained just how far it should go down on the root, remove it, and with the small spring punch in the collar pliers form projections on the inside of the band at the proper points to serve as stops, which, resting on the top of the root, will prevent the collar from being forced further down upon it than is desirable (Fig. 711).

A collar for the cuspid is then fitted in the same manner, using mandrel No. 6 for shaping, after which the case is ready for the building of the bridge.

Place both collars in position and take an impression of the parts, including the interiors of the excavated pulp chambers, from which make a cast in the usual way. Bend a short piece of half-round gold or platinum wire into the form of a horse-shoe, the two extremities of which shall fit into the roots of the molar. Then take a longer piece of the same wire, somewhat more than enough to extend from the toe of the horse-shoe when in position to the cuspid root; bend one end of it at a right angle, or nearly so, to fit the root of the cuspid, and (cutting off any excess of length) solder the other end to the toe of the horse-shoe. The bar extending between the two roots is the truss of the bridge. Next, place the appliance on the cast (Fig. 712), holding it in position with wax,

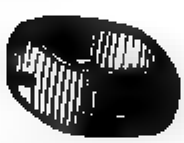
and select the teeth to take the place of the missing bicuspids and molar. The best form for this purpose is a tooth having holes extending through it vertically from the neck to the grinding surface, similar to the well-known Bonwill crown.

The crowns used should be large enough to fill the space rather tightly, even if their sides have to be flattened slightly to let them in. If the teeth do not fill the space tightly, a small portion of plastic

Fig. 710.

Fig. 712.

Fig. 711.



filling material crowded between them, as mortar between the granite blocks in the arch of a railway bridge, will greatly increase the strength of the work.

After the teeth are ground to fit and the proper length for occlusion is ascertained, the truss is covered with a thin film of wax, upon which the crowns are again pressed to their positions. Upon the removal of the crowns the impression of the holes running through them will be found in the wax. At these points drill holes through the bar with a small twist drill run by the engine, and into these fit and solder the pins for the support of the crowns.

The bridge is now ready to be attached permanently. Set the crowns in position upon their supporting pins to secure the proper alignment. (If the operation were upon the upper jaw they would have to be held with wax.) Put into the canals of the supporting roots (the cuspid and first molar) a sufficient quantity of some quick-

setting plastic, as oxyphosphate, to about half fill the pulp-chamber, but not enough to prevent the supports of the truss from being forced home. Force the bridge supports to place, and after allowing the filling material to become set remove the crowns. Fill the remainder of the pulp-chamber and the whole of the collar with gold or with amalgam, gutta-percha, oxyphosphate, or any suitable plastic (Fig. 713). Set the crowns permanently, the molar and cuspid first, as this affords greater facility for the trimming off of any excess of the filling material used in the attachment. For attachment of the crowns, gutta-percha is probably the best material, as crowns set with it are readily removed for the correction of any inaccuracies of occlusion or alignment, by grasping them between the beaks, previously warmed, of a pair of universal lower molar forceps. The heat warms the gutta-percha and releases the tooth, which can then be re-set properly. In attaching crowns with gutta-percha the holes in the crowns are first filled with the material, after which the crown is warmed and

FIG. 714.

forced to place. Any of the other plastics ordinarily used in setting Bonwill crowns can be employed at the discretion of the operator. Fig. 714 shows the case completed.

In securing the occlusion of a piece of bridge-work it is well to make the artificial teeth a little short, so that the natural teeth on both sides will meet the first shock of mastication. Nature will correct the occlusion in time by slightly elongating the roots supporting the bridge. If the artificial crowns are permitted to strike the natural teeth from the first, the undue strain upon the two supporting roots may cause soreness and perhaps more serious consequences.

When a sound tooth is to be used as one of the supports of the bridge, a modification of the method just described is necessary. Take a case where it is desired to bridge the space caused by the loss of the right inferior bicuspids and first molar. The crown of the right cuspid is nearly gone, but the root is sound and capable

of supporting one end of the bridge. The other end will be attached to the second molar, which is a sound tooth. Prepare and band the cuspid root as before; dress off the second molar crown until it is slightly smaller than the neck, so as to permit a cap to be telescoped over it, and take the measure of the crown with the binding-wire. Select a suitable seamless collar of sufficient width to extend from the neck to a little beyond the grinding surface, and drive it up on the proper mandrel to get the general shape, but not the full size required to fit the tooth, leaving it so that the edge having the larger circumference will just pass over the end of the crown; place the collar on the tooth, and with a block of wood and the mallet tap it to place just beyond the free margin of the gum. This method will make a close fit, as the collar will readily stretch all that is necessary. With a sharp-pointed instrument mark the length of the crown, remove the collar, and cut it to the proper width as indicated. Then in a piece of gold plate of the thickness used for caps form four little depressions of the general character of an im-

Fig. 715.

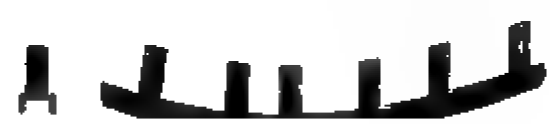
pression of the molar cusps. An easy way to do this is to lay the plate on the lead anvil; then with the ball on the end of an ordinary socket-handle and the hammer the depressions are made in a moment. Set the collar on the plate, borax it, charge with solder, and heat till the solder flows. Cut off the surplus plate, and a perfect cap for the molar is made. Place it on the tooth and take an impression, and thereafter proceed as before directed to make the truss of the bridge and mount the teeth, except that in this case the posterior end of the truss is to be soldered to the molar cap. For the final attachment place a little oxyphosphate or any other plastic filling material in the cap to secure it firmly (Fig. 715), first cutting a slot in the crown end of the cap for the escape of the excess of material. Pressure upon the filling material hastens its hardening.

DETACHABLE BRIDGE-WORK.

A description of two or three methods of constructing detachable bridges will suffice to indicate the general principles involved. Having these, each operator will find it an easy task to devise the modifications necessary to adapt a method to individual cases.

The first method is especially applicable to cases where both ends of the bridge are attached to roots,—as, for example, the inferior cuspid and second molar roots of the right side, the intervening teeth having been lost. The operation is conducted as described in the first case of fixed bridge-work down to the construction of the truss, for which in this method square gold wire is used. Having cut the wire of the proper length, lay it upon a piece of gold plate (about No. 29, American gauge) of the same length and full three times as wide, and placing the two upon the lead anvil, with a hammer and the piece of file before used drive them into the lead. This will form the plate into what we may call an open trunk, which fits the square wire. Remove the two from the lead together, and, without separating them, curve to the proper shape to form

FIG. 716.



the truss. Grind crowns having vertical holes, like the Bonwill, to fit, and having determined the proper points for the supporting pins, by the method already described, drill through both trunk and bar at these points. Separate the bar from the trunk, and fit and solder pins to the bar. Construct small tubes to fit the pins, ream out the holes through the trunk to admit them, and set the tubes with solder in the enlarged holes (Fig. 716). Fix the crowns permanently upon the tubes. They may be mounted in any of the approved ways, by vulcanizing or by the use of a plastic filling material. When they are firmly set, place the trunk with the teeth upon the bar, and

anchor permanently as already described. Fig. 717 shows the completed work.

In this method the truss consists of the bar and the open trunk which covers three sides of it. The bar is, of course, permanently attached to the roots of the molar and cuspid, but the trunk with the teeth can be removed at any time.

The second method of constructing a detachable bridge is applicable to cases where one or both of the supports or piers are sound teeth. In the case adduced for illustration the right inferior cuspid crown was decayed, and both of the bicuspids and the first molar

Fig. 717.

were absent. The supports for the bridge were the sound second molar and the cuspid root. After the cuspid root was prepared and banded, the crown of the molar was reduced very slightly,—not sufficient to destroy the enamel, but just enough to permit a collar properly fitted to pass over it. A collar somewhat wider than the length of the crown from grinding surface to neck was fitted and cut to the proper width. Two lugs were then soldered upon the anterior and posterior sides and bent to fit into the approximal fissures, which were slightly cut out to admit them. An impression was taken, the collar coming away in the plaster, and a cast was made with the collar in position. A coned tube was then made for the root of the cuspid and a coned pin fitted into it. A truss of half-round wire was made, to which the coned pin and the molar collar were soldered (Fig. 718). A half-clasp to grasp the lateral was next soldered to the end of the truss to be supported by the cuspid. The object of this clasp was to guard against the teeth being thrown out of proper alignment by the force of mastication. Bonwill crowns were then vulcanized to the truss, after their supporting pins had been fitted and soldered to it. (Countersunk crowns can be used as well in the same way. Plain plate teeth may also be used in this style of work, in which event they are to be

soldered to the truss.) The bridge was then ready to be set, which was accomplished in the following manner: The cuspid root was nearly filled with oxyphosphate, and the coned tube was placed upon the pin. The band was put on the molar, and the coned pin with the tube upon it was forced into the plastic in the cuspid. As soon as this became set, the tube was held permanently, while the bridge itself could be removed whenever desired (Fig. 719).

This method of fixing the tube allows considerable range in its adjustment. In soldering the coned pin to the truss, care should be

FIG. 718.

FIG. 719.

taken to set it at an angle exactly parallel to the axis of the molar: otherwise there will be difficulty in removing the bridge.

The third style of detachable bridge-work to be described involves the use of cusp crowns (Fig. 720) for supporting posts or piers. Suppose a case where both ends of the bridge are to be attached to inferior cuspid and second molar roots, the intervening teeth having

FIG. 720.

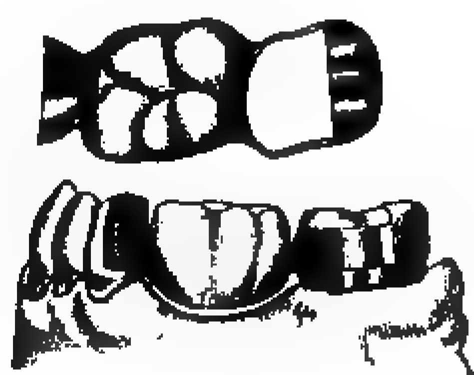
been lost; the bridge is, therefore, required to extend from the right inferior cuspid to the right inferior second molar, with only the roots of the two teeth named as supports. Prepare the roots and pulp-chambers. Set screw-posts into the dentine for anchorage or as retaining-pins, and fit the collars, using sizes wide enough to form the walls of the crowns. Fill the pulp-chamber and about two-thirds of the depth of the collars with a plastic filling material, packing it well around the retaining posts. Select suitable cusp crowns for the

molar and cuspid and place them in the ends of the bands to ascertain the occlusion. If too long, shorten the cusps or reduce the bands with engine corundums or rotary files, and when the correct articulation is found form a small square shoulder in the lingual edge of the cuspid and in the posterior grinding surface of the molar. Fill the remaining portion of the collars with plastic mixed somewhat thinner than the first lot, and set the cusp crowns in position. If there are antagonizing teeth the mere closing of the patient's jaws will force the crowns to place. If there are no antagonizing teeth the crowns can be readily tapped to place with the mallet, using a piece of wood as a driver. Allow the filling material to set firmly, trimming off any excess which may exude around the collars.

Bridge supports or piers constructed on this plan are strong and durable, and likely to withstand any strain. Take an impression, and proceed to fit seamless collars to telescope over those already set upon

FIG. 721.

FIG. 722.



the cuspid and second molar roots. It will be remembered that these collars are so made that each size telescopes into the next higher series. If the proper sizes are selected for the outside or female bands, the work of fitting is readily and quickly accomplished, forming tubes which slide easily over the supporting piers, and at the same time fit closely. It is only necessary to take care in shaping the tubes not to drive them too far up on the mandrels and thus stretch them so as to destroy the fit. To the outer end of each of the tubes solder a small piece of gold plate, forming partial caps so placed as to rest when in position upon the shoulders previously cut in the cusp crowns. Adjust a truss bar of half round gold wire, to the ends of which solder the tubes (Fig. 721). The truss is now ready for the teeth, which may be

of any of the forms used for this purpose, and they may be attached to the bar in any way desired. One of the strongest attachments is vulcanite.

An easy modification of the plan just described is readily adapted to cases where only a small space is to be filled and one end of the bridge is to be supported by a sound tooth. Thus, suppose it is desired to bridge a space formerly occupied by the two inferior left bicuspids, the crown of the first molar being a mere shell. The operation would be essentially the same as in the previous case, except that the sound cuspid would be utilized for one of the piers as follows: Fit a seamless collar, cut out a portion of it so that it will embrace only about two-thirds of the cuspid crown, and solder a partial cap or cover to it, as illustrated in Fig. 722. Or, if deemed preferable, the cuspid may be separated from the lateral incisor with the corundum disk and the collar allowed to embrace the whole crown.

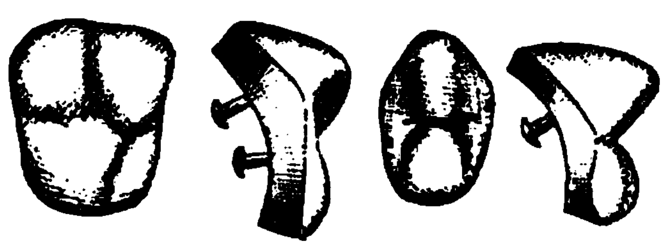
The great desideratum in constructing a piece of bridge-work is, of course, the securing of perfect usefulness in mastication and speech, combined with absolute comfort and cleanliness. The closer a bridge approaches that condition where its wearer loses consciousness of its presence in his mouth, the nearer perfection it is. Scarcely less important, however, is the necessity of providing for repair. Accidents will occur, and the system which superadds to usefulness, comfort and beauty, ready facilities for repairing breakages, is by so much superior to those which make no such provision. A crown broken from a bridge constructed by any of the methods above described can be easily substituted, and the piece when repaired will be as strong and serviceable as it was originally.

It has not been deemed necessary to detail the construction of a single crown separately, as all the steps are included in the building of bridges, which have been described minutely. Porcelain cusps of the general form illustrated in Fig. 723 have been designed specially for these cases. In mounting them the gold band is cut away on the buccal side as shown in Fig. 724 to permit the porcelain to show.

Dr. C. M. Richmond, of New York City, in making removable dentures of the entirely soldered kind, employs a zinc die made from a cast of the anchor tooth with its cap on. He makes of crown metal (platinum faced with gold) a collar somewhat smaller than the tooth-cap, and deep enough to reach from the gum to about a sixteenth of an inch above the cap. He then drives the die into the collar so far that the extra sixteenth of an inch can be ham-

mered over and burnished down on the die-end to form a flanged collar. Outside of this, in the same manner, he forms another flanged collar, and then solders the two together, thus obtaining a close-fitting stiff collar, that will not stretch in being telescoped on and off the anchorage, and is kept by the flange from being forced too far over

FIG. 723.



the tooth-cap. A denture of this kind is illustrated in Fig. 725, which also shows his post and roof device in another form than that previously described.

It may be well to add that, in the use of an impression cup for holding the plaster and sand around the parts to be subsequently re-

FIG. 724.

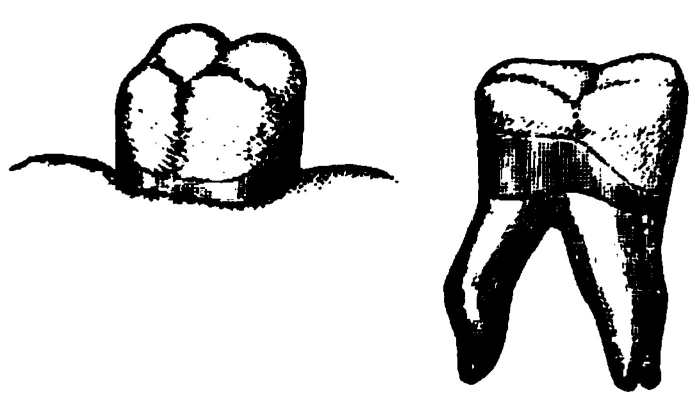
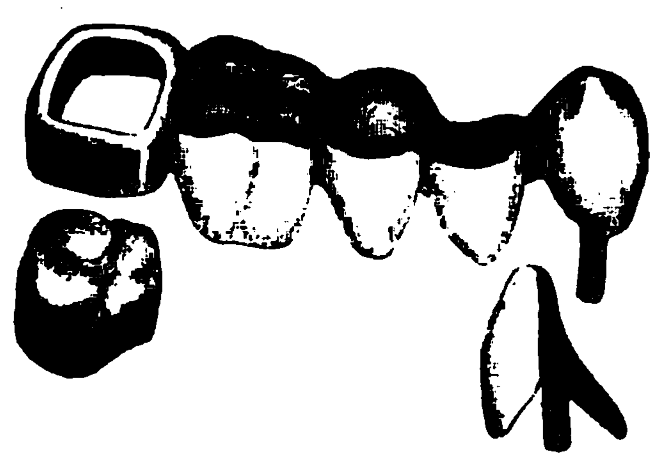


FIG. 725.



moved from the mouth, the *inside* of the cup should first be slightly oiled, to allow a separation of the cup when the mass is being prepared for the soldering.

A removable bridge-work is suggested by Dr. T. S. Waters, which is described as follows: "The natural molars and bicuspids, one or more of each class, are capped with gold crowns, each molar being double capped, and the outer cap containing two small springs constructed of small strips of elastic metal (gold and platinum), one end of each spring being soldered to the inner surface of the cap near its base at the neck of the crown, and the other end free to press on the side of the inner cap. Such springs retain the outer cap fitting over the inner one on the prepared natural crowns by their pressure on the sides of the inner caps, the latter being cemented to the natural crowns.

"The band for the natural bicuspid crowns has two shoulders on the inside which fit into grooves cut in the mesial and distal surfaces of the gold forming the crown."

Dr. James W. Low, the inventor of what is known as the "Low method of bridge-denture," describes it as follows:—

"My experience has convinced me that, as a rule, a tooth firm in the jaw need not be extracted. There are but few exceptions. When the treatment is followed persistently, and proper judgment used, nearly all the partial loss of the teeth can be restored without covering the roof of the mouth, and made as valuable for masticating food as the natural teeth, I am positive, and with less injury to the remaining teeth, than by any other method. The method referred to is that known as the 'Low method,' or bridge-work.

"Bridge-work consists in supplying vacancies between teeth or roots with artificial teeth, attached to the adjoining natural teeth or roots by means of bands or crown, and held in such position that

Fig. 726.

there is no contact with or pressure on the gums beneath, and thus no opportunity for secretions or other foreign matter to be held there and thereby become offensive.

"There is really but one kind of bridge-work, and but one way to make bridge-work to insure success. There are many ways of making teeth without plate, but this is not bridge-work. I will here try to explain in detail my manner of making and adjusting bridge-work.

"For the first illustration, as seen in Fig. 726, we have a case where all the teeth have been extracted, except the two cuspids and two second molar roots.

"We first proceed to prepare the roots by crowning. I use gold crowns on the molar teeth, and what is known as the Low crown on the two cuspids.

"The preparation of the two cuspids consists in making the crown ready for adjustment. I always measure the tooth to be crowned with gold with a strip of block tin, 35 thick stub gauge or thereabouts. Place the tin around the tooth, and with pliers carefully measure the full size of the same.

"Should you be measuring a tooth, or part of a tooth, on which there are projections, take the engine, and with a stone grind off the same, making a smooth surface, so there will be nothing to interfere with the fitting of the bands properly. After cutting the tin measures by the marks made by the pliers you have the measures ready to make the gold bands by. Cut the bands and bevel the edges, and solder together, and you are ready to fit. After fitting all the bands, and finishing the crowns in the usual way, I place each in position in the mouth, having previously regulated the articulation of each crown as desired, in the process of making. We now take a deep articulation in wax, and impression in plaster of Paris; remove before it gets too hard, and place all the crowns in their positions in the impression; varnish, oil and pour in the usual way; separate the cast from the impression and place in the articulator. Then pour plaster. After the plaster has hardened, remove the wax and we have the articulation proper, and are ready to select and grind our teeth, having previously selected our shade. My experience has long ago taught me that no porcelain teeth can stand the pressure for bridge-work, the strain on them being twice as great as with teeth on plates, which rest on the gums that give to pressure. In order to prevent breakage of teeth and give strength, I have for many years been making a tooth with gold cusps. I will here describe my manner of doing so. I had some shells of bicuspids and molars made, or rather teeth, without the crown. They can now be found in some of the depots.

"For the first step, I use 28-gauge platinum for a covering of the inside of the shell, or just where you wish gold to flow. Then I bend the pins down to hold the platinum in position, and with a file remove all overlapping platinum to prevent breaking of our tooth in heating. The tooth is made flat on the crown surface with the express intention of restoring with a gold crown. This crown need not be very thick, but should perfectly resemble the cusps on the natural tooth, for the purpose of mastication. As these cusps are not on the market, and every dentist making bridge-work cannot make it in a way to stand, without putting gold cusps on the grinding surface of the bicuspids and molars, I will here describe for the benefit of those who do not know how to make them, how they can be made with very little trouble. Pick out a

natural tooth with cusps the exact shape you wish to have your gold cusps, mix some fire-clay in a thick paste, then press your tooth into it a little deeper than you wish the cusps. Having made the proper impression, remove the tooth, and set the impression over the gas stove to dry. After it is dried and reasonably hot, lay your pieces of gold in the impression and, with a blow-pipe, melt them. When melted, press with a piece of steel on the gold till cool. This mould will do to make many from. If you have not the fire-clay and can get charcoal that is burned from fine-grained wood, and is soft, you can simply press your tooth into the charcoal and melt in the same way, or you can carve your teeth as you desire in a block of carbon. Of course the little steel dies are handier, as we can swedge up our gold cusps in them, either solid or thin.

"Having described our manner of making the cusps, we will now return to the manner of finishing our tooth. We left off by saying we covered the inside and bent down the pins and filed off the over-

Fig. 727.

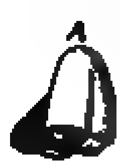


Fig. 728.

lapping platinum. We now place the cusp on the top of the tooth, and place in the position desired, holding it there with wax, and with a spatula trim the wax the exact shape we wish our tooth to be, V-shape, tapering from the crown down. We now encase in plaster and sand, which gives us a box. When hard, remove the wax and place over the stove, and when sufficiently dry fill in with coin gold, using the blowpipe to melt it in a solid mass, and then our tooth is ready to file up and place in position on the articulator. Fig. 727 shows the tooth in this condition.

"After our teeth are all arranged we hold the same in position with wax, remove from the articulator, encase with plaster and sand or asbestos in the usual way. That we may have a strong case, I always use platinum wire between each tooth, and then proceed to heat and solder. Be sure that all the gold cusps are so arranged that you can get all soldered together, as this gives us great strength. My formula for solder, which I have used for many years and

which will be found very easy-flowing and almost the exact color of the gold you are using, is as follows: Always figure from the carat of gold you are working. Take 1 pennyweight coin gold, 2 grains of copper, and 4 of silver. We now have our case soldered; after filing as desired, commence to finish with felt wheels and pumice stone, after which we use rough buff wheels. We are now ready to adjust in the mouth. In Fig. 728 we see the case ready for adjustment.

"Have the assistant dry all the teeth or roots to be operated upon while you are mixing the cement. Be sure and use a kind which does not harden very rapidly, or your cement will set before you get your teeth adjusted. Use sufficient cement to fill all the gold crowns perfectly when the case is driven to place. Moisten the step plugs and cap with cement, touching every portion, and with an instrument place a little cement in the bottom of the cavity.

FIG. 729.

We now adjust our case, using the little rotor for the low crowns, and a piece of ivory for driving on the gold crowns. Fig. 729 represents the case when in position.

"It will be seen by looking at the previous cut (Fig. 728) that the teeth, after having been soldered, are all spaced fully one-third of the distance from the place of contact with the gums and the grinding surface of the teeth, so that secretions could not possibly lodge there. I have given you a description of my manner of making a full upper case of bridge-work, where there are roots to be crowned to support the bridge. I will now describe my manner of operating upon a case where the four centrals are missing, as seen in Fig. 730. To supply these four teeth where the cuspids are intact, I use a gold band.

"I first measure the tooth with strips of tin and make the gold bands as before described, cut out the outside lower portion of the band before beginning to fit. In fitting, as the band is being driven

down, cut away any of the band that touches the gum before all touches; never drive the band under the gum, as inflammation would probably follow.

"I mention this, as I have seen many attempts to get rid of the band by driving up under the gums and cutting them out on the front, until they were too narrow for strength. It is hard work to make something out of nothing. The bands should be heavy and strong, and the patient made to understand that if he expects to get rid of the annoyance of the plate he must sacrifice his dislike to showing gold. After driving the bands up close to the margin of the gums, as the cuspid teeth are very tapering, the bands will have to be

Fig. 780.

Fig. 731.

taken in at the bottom. To do this I slit the band about a third of its length up, then place it on the tooth again, lap it over enough to bring it to a close fit, and then take it off and solder.

"Continue taking it in wherever it does not perfectly fit the tooth, and after a good fit is obtained proceed as before described by taking an articulation and impression. In adjusting first try the case on to see that it fits and that the articulation is all right. Fig. 731 shows the case ready for adjustment.

"Next, have the assistant dry the teeth upon which the bands are going, and then mix your cement. This should be mixed to about the consistency of thick cream. It must be neither too thick nor too thin, or the adhesion will not be strong enough to hold. Cover your teeth with cement and then the inside of the bands. Place these on the teeth and carefully mallet up into position. For this purpose I use a steel instrument with a crease or groove in the end. The teeth must be kept dry after the case is in position until the cement is well set. After this is done bevel the edges of the bands and burnish close to the teeth, and if properly done they will be made to resemble gold fillings.

"In Fig. 732 we have the case completed.

"I am aware that in a case like this, porcelain crowns instead of gold bands could be used, and I should consider it much preferable to do so where we have roots or unsound teeth to operate upon, but do not advise the destroying of nerves where the teeth are intact to supply such a case with crowns, as the bands will answer every purpose for many years.

"If they should give out in after years the roots can then be crowned. I have many of these cases that have been in use seven and eight years, some of which have never loosened, and some I

Fig. 732.

have reset nearly every year. I always impress upon the patient the necessity of having them reset immediately, should they become loose, and advise them to have their cases examined at least once a year. Should parties insist upon having crowns used to supply a case like the one just described on perfectly sound teeth, I should begin by using an aluminum disk, with corundum, cutting deep as possible, both on the labial and lingual sides. Then use the excising forceps. This can be done under the influence of an anæsthetic or otherwise. It is not by any means so painful an operation as one would think. If the nerve does not come out with the piece of tooth cut off, I take a piece of orange wood which I have previously cut the proper shape to drive into the nerve canal. I place it in creosote and let it soak a few minutes before beginning to operate. Immediately after severing the tooth, drive this into the canal, then remove, and dip in creosote and drive in again. This will perfectly fill the nerve canal; all sensitiveness will disappear, and you can begin to operate at once. I do not recommend this treatment for sound teeth, but I have treated many exposed nerves in this way; also many teeth broken by accident, and think this the most satisfac-

tory way to dispose of such cases. I have never had any unfavorable results follow after operating upon teeth in this way, and I can hardly say as much in favor of any other treatment. I speak of this manner of treating exposed nerves as one of the operations that sometimes become necessary in adjusting a bridge properly. I do not claim any originality in this mode of treatment. I know several dentists who use this method, all of whom report satisfactory results. We now have Fig. 733, showing the roots prepared to receive the case.

Fig. 733.

"I have many of these cases in use that are giving entire satisfaction. The instrument selected for preparing these roots should be one

Fig. 735.

Fig. 734.

with small inside cutters and large bevelers, so as not to cut away any more tooth-substance than possible.

"Fig. 734 represents the case ready for adjustment.

"Fig. 735 represents the case after adjustment.

"In this article I have described my manner of making teeth for

bridge-work, and I am now using a tooth made expressly for this work.

"The following Fig. 736 shows us a socket. These are ready made in various sizes in bicuspids and molars with corresponding shells.

"Figs. 737 and 738 represent the shells placed in sockets. Fig. 737 is a molar tooth showing the shell in position, and 738 is a central reversed.

"Fig. 739 represents the socket as made for the four central and two cuspid teeth. The advantage of these teeth can readily be seen,

FIG. 736.

FIG. 737.

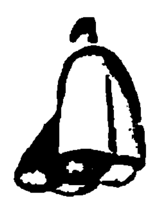


FIG. 738.

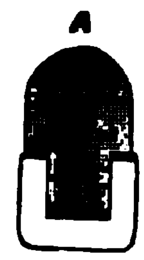


FIG. 739.

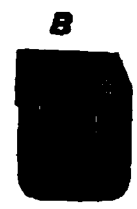


FIG. 740.

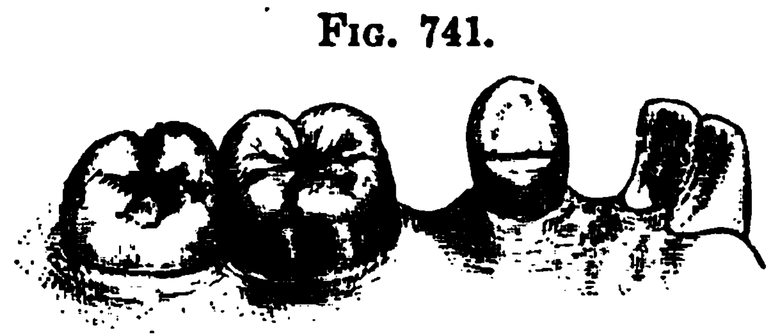
not only for bridge-work but all gold plates. A tooth, if broken, can readily be replaced without removing the bridge or cracking by soldering, and with only a small expense.

"Fig. 740 represents the shell placed in position in the socket, which can be used for bridge or crown work, and will greatly reduce the labor in making either."

Dr. G. W. Melotte describes his system of bridge-denture as follows:—*

"Fig. 741 illustrates a case for the supply of a lateral and a bicuspid. In this instance the cuspid could be cut off, and the root collared

FIG. 741.



and capped in combination with a pin entering the enlarged pulp-canal; but, as there may be grounds for objection to cutting off sound teeth, I obviate the necessity by cutting a shoulder on the lingual portion of the cuspid, and suitably shaping its sides to permit a close-fitting collar just under the free margin of the gum. A narrow strip of pure pattern tin, bent tight around the tooth-neck, and cut through with a knife at the lap on the labial surface, will serve as a measure for the length of a strip of 22-carat gold plate,

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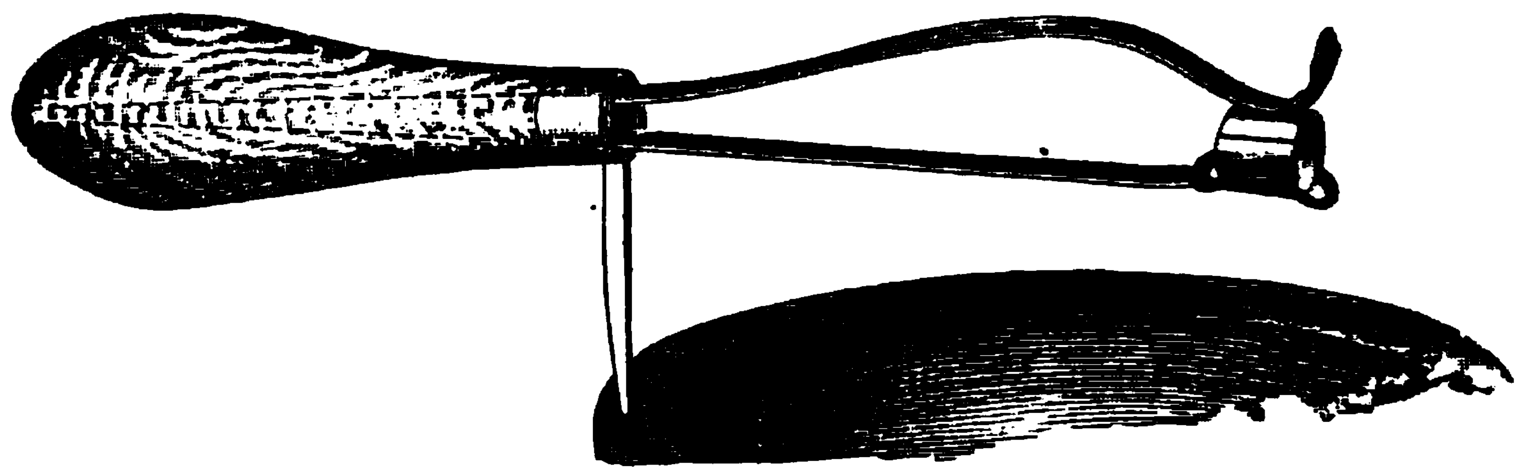
* *Dental Cosmos*, Decem. No., 1886.

No. 29 thick, and as wide as the length of the distal side of the cuspid. The ends of the gold are then squared, and with round-nosed pliers brought evenly together, to be held in flush contact by the soldering-clamp shown in Fig. 742. The soldered collar, with its joint side inward, is then adjusted on the tooth as accurately as possible, giving slight blows with a mallet until the collar touches the gum, when it should be marked to indicate the necessary trimming to conform it to the gum contour. After it has been thus trimmed, the edges beveled, the labial part swelled with contouring pliers, and the lingual part cut down to about one-tenth of an inch in width, the collar is again driven on, and will appear as seen in Fig. 741. A stump corundum wheel is then used to grind a shoulder on the lingual surface of the tooth, grinding also the edges of the collar flush with the shoulder. The collar is again

FIG. 742.



removed, and a piece of thin platinum plate, about No. 32, sufficient to cover the lingual surface of the tooth, is caught on the lingual edge of the collar by the least bit of solder, and all put in place on the cuspid (see Fig. 743). The platinum should now be burnished on to the shoulder, and over the tooth and collar to the extent shown by the lines in Fig. 743. After trimming to those lines, and careful replacement and burnishing on the tooth, the collar and half cap are removed, filled with wet plaster and sand, and the platinum soldered to the gold. It is then placed on the tooth, burnished into all the inequalities of the tooth, very carefully removed, invested, and enough solder flowed over the platinum to cover and give it strength. Fig. 744 shows it complete on the cuspid.

"I have feared that a detailed statement would imply a long and tedious process, but I have often made such collars in less than an hour, and in any case time must be made subservient to exactness of fit and adaptation to the end in view.

"In the preparation for fitting a collar on the first molar (Fig. 741), I should have wedged or otherwise separated it from the second

molar, so that a piece of sheet brass might be put in place, as shown by Fig. 745, and an impression taken in plaster, which if allowed to get hard would bring away the metal. If not, it could be replaced in the plaster. Melted fusible metal, when near the cooling point, is then poured into the impression, and when cold will allow the safe removal of both the plaster and the me al strip. On this metal model a collar can be formed that will accurately fit the molar, as seen in Fig. 741. If the molar has no antagonist, a cap may at once be struck up on the model, but if there be an antagonist the cusps

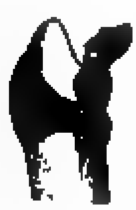
Fig. 743.


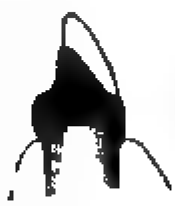
Fig. 744.


Fig. 745.


Fig. 746.


of the natural molar should be removed by grinding at points where the occluding tooth will admit of sufficient thickness of the gold cap. An exact copy of the ground cusps can then be made in less than five minutes, by the use of moldine with its accessories, and the process is as follows: Make the tooth perfectly dry. Put the collar on it. Nearly fill the cup (Fig. 747) with moldine, and coat it with soapstone powder. Press the compound on the tooth and collar firmly to about one-fourth the depth of the tooth. Carefully remove the

Fig. 747. Fig. 748.

cup; trim off any overhanging material, and place the rubber ring over the cup to about one-half the depth of the ring. Melt the fusible metal and pour it, as cool as it will run from the iron ladle. As soon as the metal is hard, remove it with the ring (Fig. 748), taking care not to impair the impression, which can be used again if the die is found imperfect or gets injured in use. Place

the die and ring in cold water, to remain until quite cooled. While the die is wet and held over a basin of water, pour into the ring fusible metal which has been stirred until it begins to granulate, and quickly immerse all in the water. The die and counter-die should separate readily by tapping them with a hammer, but if they stick, others can be quickly made from the same impression, by the same method, using more care. With this die and its counter-die, a piece of No. 29 or 30 gold plate is swaged to fit perfectly the cusps and collar, which, when removed, can be held to its place on the cap by the soldering-clamp, using spring pressure enough merely to hold them together for careful soldering with the pointed flame so as not to unsolder the collar. The seamless collars are excellent when care is used in selecting the proper size, as directed on the diagram.

"The caps being in place on the cuspid and molar, an impression is taken with plaster; the caps accurately set in the impression, and hard wax melted with a hot spatula around the edges of the caps. The impression is then thoroughly coated with sandarac varnish, after which it is dipped for a moment in water, and filled with a wet mixture of one part marble-dust with two parts of plaster; using great care to perfectly fill the caps and moulds of the teeth. Wait until this mixture has become quite hard; remove the cup, and with a suitable knife chip off the plaster without marring the cast; secure a good articulating impression, and transfer it to the cast to obtain an exact reproduction of the relative occlusions of all the teeth involved. With such an articulation in hand, and with the means already described for swaging gold or platinum plate to fit the cusps and articulating surfaces of either the natural or artificial teeth, it should be within the capacity of any competent dentist to complete a suitable bridge; although there are practical points that can only be imparted by clinical instruction and actual demonstration in the mouth. Such a bridge is shown in position by Fig. 746."

Dr. R. Walter Starr describes a bridge-denture which can be removed for repair in case of injury, as follows:—*

"It will doubtless be admitted that in some cases bridge-work has advantages over the ordinary plates for partial dentures. It will also be conceded that the security and permanence of the fixture enhances its practical value to the patient so long as all goes well. But if for any reason it shall become necessary to remove the bridge, for repairs or treatment of the roots used as anchorage, its fixedness proves a serious objection.

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* *Dental Cosmos*, vol. xxviii.

"In the endeavor to provide a remedy for this defect, the structures now to be described originated, and will, it is hoped, be found applicable in many instances in such cases as are typified by the accompanying illustrations.

"In the construction of such bridges the first thing to be done is to grind with engine-corundums the overhanging edges and sides of the teeth which are to serve as abutments, so that the crown-ends shall be slightly smaller but of the same shape as their necks. This can be demonstrated by bending a piece of fine binding-wire around the tooth-neck, and twisting the free ends together to form a close-fitting loop, which, if the tooth has been suitably shaped, may be slipped from the tooth without changing the form of the loop, thus giving an exact outline of its form and size. Such a loop is shown in Fig. 749. The loop is then laid upon an anvil, and the squared end of a short piece of wood placed over the wire, and a blow struck to drive the loop into the wood as a guide in shaping the wood to the precise size and form of the inside of the loop, as in Fig. 750.

FIG. 749.

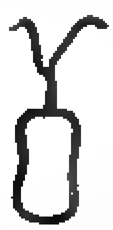


FIG. 750.

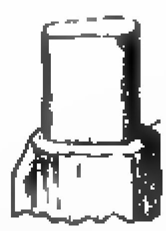


FIG. 753.

FIG. 751.

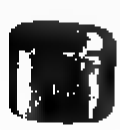
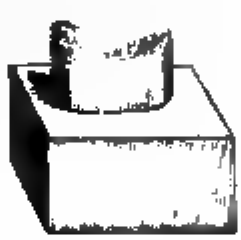


FIG. 752.



The free end of this wooden mandrel must subsequently be slightly reduced so as to conform exactly to the natural crown. In lieu of this method an exact impression of the tooth may be taken in plaster to serve as a mandrel. About a sixteenth of an inch is then ground from the occluding cusps of the abutment teeth, and an impression taken of the teeth and surrounding parts, to obtain a model, as shown in Fig. 753. A piece of gold plate, say 22-carat fine, number 30 gauge, is cut and fitted closely around the mandrel, and its ends soldered to make a collar, as in Fig. 751. This is laid with the crown end upon a piece of lead, and a piece of wood or metal laid over it and struck with a hammer to drive the collar into the lead so as to hold it securely and maintain its form, while with a smooth, half-round file the

neck end is shaped as seen in Fig. 752. The other end of the collar is then cut so that the depth of the collar shall a little exceed the visible length of the tooth, thus allowing the neck end when placed upon the tooth to pass beneath the free edge of the gum. A piece of gold plate, either plain or struck up in cusp form, is then soldered to the crown end of the collar. If a seamless collar is used it can be laid upon the plate for soldering without an investment or a clamping wire. A piece of thin platinum plate, No. 36 gauge, a little wider than the space to be covered with the teeth, is fitted and burnished over the space between the abutment teeth, which have been so trimmed that the caps described will slide on and off easily. These caps are now cemented to the platinum plate, and collars made and fitted to properly fill the space between the abutment teeth. They are held in contact with each other and with the platinum plate by running melted white wax in and between

FIG. 754.

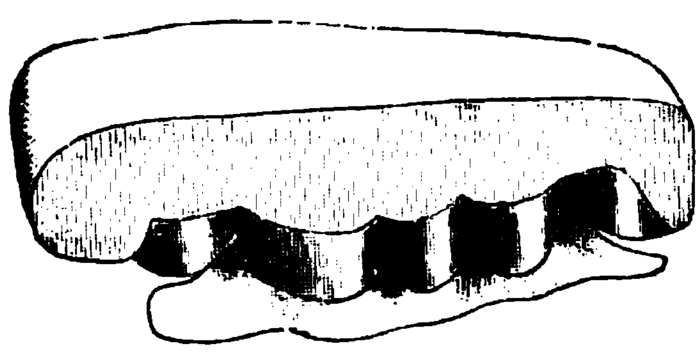


FIG. 755.

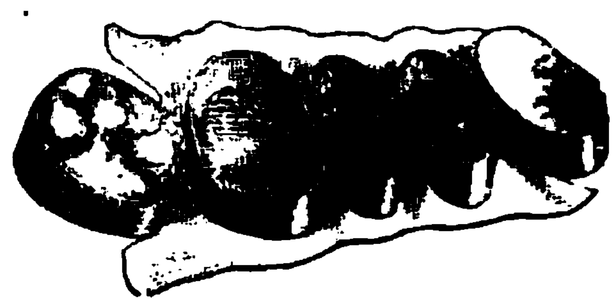
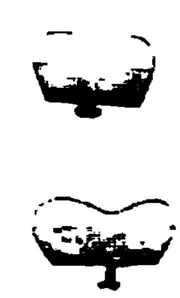


FIG. 756.



them. The whole piece may then be transferred from the model to the mouth, and stiff mixed plaster and sand pressed into and over the collars and caps. When the plaster has set the mass may be removed, trimmed, and the wax melted away with a result as shown in Fig. 754. The lines of contact of the collars with each other, with the caps, and with the plate are to be neatly soldered, when the investment may be removed, leaving the bridge as shown by Fig. 755. The free edges of the plate may then be trimmed to the margins of the collars or caps, and the whole denture polished. The bridge may now be slipped on and off the natural abutment teeth with just enough of friction to retain the denture in position and yet allow of its ready removal.

"Suitable cusp-crowns (see Fig. 756) are now selected, the cups partly filled with wax, and the cusps placed in position. The denture is then tried in the mouth and the proper occlusion obtained by grinding or filing the edges of the cups. The piece is now to be thoroughly cleansed and dried; the cups nearly filled with insoluble cement, or hot gutta-percha; the cusp crowns set in the cups; the bridge put quickly in place, and the patient directed to firmly and repeatedly close the jaws to properly determine the occlusion. It

will be found best to place a piece of paper the thickness of a postal card over the porcelain cusps when forcing the denture to place, so as to insure that they shall be a little short, and thus avoid irritation of the anchorage teeth in mastication. These anchorage teeth or roots will in time elongate and form a close occlusion.

FIG. 757.

"When the cement is properly hardened the piece may be removed. A hole should now be drilled through the metal caps to allow escape of surplus filling material. A small quantity of gutta-percha thoroughly warmed should now be placed in the caps, and with a

FIG. 758.

piece of card placed between them and the occluding teeth, the caps should be forced home.

"The completed case is represented in Fig. 757.

"The bridge may at any time be removed with warmed forceps beaks held long enough on the caps to soften the gutta-percha. The cusp crowns may be removed, if desired, by the same method and replaced without detaching the bridge.

"A modified bridge is shown in Fig. 758. It will be observed that collars have been firmly fixed with cement or gutta-percha on the

abutment teeth, which have their occluding surfaces ground flat on their inner aspects, so that the partial cap shown may thus prevent the telescoping collars from being forced too far down on the teeth. By means of a frame saw a narrow tongue is cut on the outer face of each telescoping collar, the free portion serving as a spring clasp to hold the bridge securely on the abutment teeth and still allow the removal of the piece whenever so desired. Fig. 759 shows such a bridge in place. It is obvious that if in this instance the roots only of the cuspid and second molar had been present, they could, by means of the collar and cusp-crown devices, have been put in shape to serve as abutment teeth for the telescoping bridge shown in Figs. 758 and 759. The second molar roots so crowned are seen in Fig. 760. When it is desirable to show the faces of the porcelains to a greater degree, the collars may be cut away on the buccal sides

FIG. 759.

FIG. 760.

FIG. 761.

and the countersunk crowns be used as illustrated by Fig. 761. The platinum base may either rest broadly upon the gums or be sloped so that only the buccal border shall touch the gums, or it may be so shaped as to be entirely free from the gum. This is done by building upon the plaster cast, and bending the platinum plate and shaping the gold tubes to the surface so made, depending wholly for support on the abutment teeth or roots.

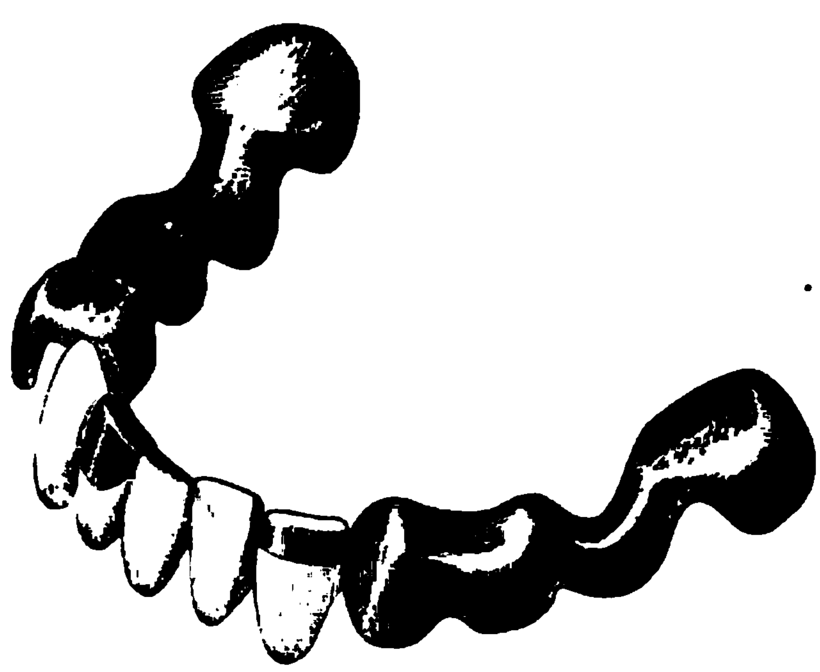
"Briefly stated, the points of excellence in this bridge are strength, lightness, avoidance of liability to breakage of the porcelain in soldering, ease of construction and adaptation, and the facility with which it may be reorganized, or for any reason be removed and replaced. This last feature is of special value in the not infrequent event of subsequent alveolar abscess, for in cases such as are shown in Fig. 757 the bridge may be removed, the involved teeth drilled, medicaments applied, the bridge replaced, and this process repeated without depriving the patient of the use of the denture."

In the *Dental Cosmos*, Dr. Dexter describes a removable-bridge denture or "cap-plate," as follows:—

"Take a case where, on the lower jaw, there are standing in the mouth a third molar, a canine, and first bicuspid on each side—six teeth in all. These teeth are shortened by breakage and mastication, so that the upper incisors close to within an eighth of an inch of the gum line between the canines; added to this, they are so tipped and twisted in their places as to make it very difficult to properly adapt an ordinary denture to the spaces between them; and, lastly, let the patient evince entire abhorrence of, and a fixed resolution not to permit, the resting or pressure of any appliance upon his gum-tissue. Such a case is the one for which I have constructed this cap-plate. Such cases are often treated by building up or down the natural teeth with gold, in order to open the bite, and then replacing lost teeth with an ordinary plate. My apparatus, however, accomplishes both these desiderata in one operation, while simultaneously avoiding any and all pressure upon or irritation of the gum.

"The appliance which I show you (Fig. 762) is constructed as follows: Caps of gold and platinum alloy, of about 26 to 28 U. S.

FIG. 762.



standard gauge, are struck up to fit over and down the sides of the natural teeth selected for the piers, fitting closely. If all the supporting teeth stand perpendicularly and parallel with each other, thus creating no 'undercut' (so to say), the sides of the caps may encircle the teeth as far as possible (*not*, however, impinging upon the gum-line), and be simply slit (in two or more places on each tooth) perpendicularly, so as to spring apart and allow of sliding the whole over the natural convexities of the teeth, the sides coming together again when in place and thus holding the whole apparatus firmly. But should the teeth be tipped or leaning, and not parallel, the sides of the caps must then extend over only such parts as can be closely fitted and yet be sufficiently perpendicular and par-

allel to allow of removal and replacing of the appliance. Of such a character is the case now shown you, there being only one place on the six caps where a *slit* is of value; the sides of the caps being so fitted as to hold partly by their own elasticity, and partly by that of the whole apparatus. Such a case, of course, will most severely try the capabilities of any artificial denture; and not the least merit of the present piece is its triumph over, and perfect and *practical* adaptation to, the obstacles of an exceptionally difficult case.

"The caps, when struck up, will not cling to the teeth when in place; nor should they, for they must be capable of easy removal during succeeding processes. But when the piece is ready for final insertion, the sides of the caps must be *sprung inward* sufficiently to hold to their supports with firmness.

"The caps being now made, it is in order to determine the length of 'bite' needed. Place the caps in position in the mouth, and build wax on their grinding surfaces to a proper length and contour, both side and grinding. Invest, remove wax, and flow into its place eighteen-carat gold. Shape the grinding surfaces, by trial in an articulator or the mouth, to the proper occlusion. Next, take an impression with the caps in place, pour the model, select and back plain plate-teeth, and wax them in place. Invest the whole, remove the wax from the backs of the teeth, and fit in the spaces between the caps, bands, or bars of irido-platinum alloy (or gold, as circumstances may determine), being careful that the bars fit *accurately* to the *backings* of the porcelain teeth and to the *caps* at each end. In fitting the bars to the caps, select such points of attachment as will not interfere with the *spring* of the slit sides of the caps. If necessary, let the bars avoid the *sides* of the caps, and reach, by curving, to the *tops* or grinding surfaces. Should you desire to arrange the porcelain teeth irregularly, you need not hesitate to do so. Set them just as you would for rubber or celluloid, and then, simply taking a 'finger impression' of their backs with modeling composition or wax, when invested as above stated, and making dies, you can readily 'strike up' your bars to fit the irregular positions of the backings. But should this be difficult, on account of great irregularity or stiffness of bars, then construct the bars of two or three thicknesses of metal, each struck up separately, and then 'sweated' into one. Next, solder the bars to the backed teeth, but *not* to the caps, as yet. The reason is that *perfect* adaptation of the bars to the caps is absolutely necessary to the success of the piece. Therefore, now place the caps in place in the mouth, and wax the bars with their attached teeth in the spaces between them; filling,

grinding, and adjusting until all is exactly as required. Then (and not until then) take an impression of the whole in place, the apparatus coming away with the plaster. Pour the impression with plaster and pumice, sand or asbestos (sand is best), carefully remove the impression plaster, invest outside the model with its sustained apparatus, and then solder the caps and bars together. In doing this as little solder as possible should be used, to prevent warping of the whole. The bars should have a broad, firm hold on the caps; but the contour of their union should be made on the bars *before* they are united to the caps, and *not* by flowing on a body of gold while uniting the bars and caps sufficient to attain the desired hold and shape of union. On the contrary, the bars should be properly shaped at their ends, and carefully fitted to the surfaces to which they will be attached, when a small amount of solder flowed into the joint will make a perfect union and give all the strength possible. This is *not* plumbing work. All that now remains to do is to spring or bend slightly inward, as before directed, the sides of the caps so that they may grasp their supporting teeth firmly, yet not so much as to create difficulty in removal or insertion; then finish and polish. Burnishing is generally objectionable, since it gives, in some lights, a *black shine* to the piece, adding greatly to the prominence of the appliance as a part of the view whenever the wearer opens his mouth.

"Should it be desired to produce the best possible results with the piece, the interstices between the artificial teeth and any other crevices to be found may be filled with gold or amalgam,—I prefer the former; or vulcanite may be packed in such places (which may be, if necessary, cut out to proper dimensions by burring), and finished up smoothly. The piece shown you contains no less than *seventeen* gold fillings, which signifies that no débris, or even moisture, has any foothold of concealment about it, and that it is, therefore, as clean in itself as is possible for any artificial denture to be. This, you will say, is rather expensive work. Very true. The whole method is expensive in both money and labor. But I am quite consoled for this fact by the thought that it will not, therefore, be likely to do much harm to the public, since the 'cheap-jacks' and 'incompetents' will probably let it alone.

"In the piece shown there are six caps, three on a side. There are five incisor teeth placed between the canines, two of which are capped with gold to break up the uniformity of porcelain in front, as contrasted with the uniformity of gold behind, and thus help to evade artificiality of appearance. Between the molar caps and the double caps for canine and bicuspid, the connecting-bar is horizontally

placed, dipping downward to parallel the gum line, as well as to evade an encroaching molar above. When necessary, an artificial tooth or teeth can be ground and soldered to these bars. Generally, however, the connecting-bars should be perpendicularly placed, to insure resisting strength in the line of the attacking force."

Dr. R. Walter Starr, in the same journal, describes the following case of removable bridge-denture :—

"The case of Mr. W. presented difficulties of an unusual character, as may be seen by inspecting the illustration, Fig. 763, which renders detailed description unnecessary.

"It will be observed that the molars and the left second bicuspid overhang to a degree that would make the taking of an accurate impression by ordinary methods well-nigh impossible. After a careful

Fig. 763.

study of the case it was decided that two separate pieces of removable bridge-work should be attempted, and, as an essential preliminary step, the overhanging sides of the molars and bicuspids were ground with engine corundum wheels and points until those sides were made much less inclined, when plaster impressions were taken, first of one-half, and then of the other half, of the jaw. Gold cap-crowns were closely fitted over the molars, left second bicuspid, right first bicuspid, and cuspid stump. Gold crowns were made to telescope over all the caps, which were then, by means of oxyphosphate cement, fixed firmly on the teeth. Suitable plate-teeth were selected, fitted, backed, and hard-waxed in place between the tele-

scoping crowns. After hardening the wax with cold water from a tooth-syringe, the pieces were carefully removed, invested and soldered. The two completed bridges were easily replaced on or removed from the supporting capped teeth, and their appearance when detached is correctly shown by the illustration, Fig. 764, which also shows the capped teeth and stumps. This figure likewise shows the results of the novel method employed in crowning the incisors. Gold collars were fitted tight on the necks of the incisor stumps, and the new-style porcelain caps adjusted in the collars, and set in the oxyphosphate

FIG. 764.

cement which had been packed into the collars; thus at the same time fastening the collars on the stumps and the caps in the collars, as shown completed in Figs. 764 and 765.

"Fig 765 illustrates the finished crowns and bridges, which latter were secured in position by placing a small piece of gutta-percha in each of the telescoping cap-crowns, which were then warmed and carefully pressed in place—the gutta-percha filling only the spaces between the flat tops of the caps of the natural teeth and cusped caps of the bridges.

"Whenever for repair, or for any other purpose, it shall become desirable to remove one of the bridges, that may readily be done by

applying a hot instrument or hot air to the caps, to soften the gutta-percha sufficiently to permit the telescoping bridge to be taken off.

"A full upper vulcanite denture was made to replace the old one, which, by improper occlusion, had thrown the full force of mastication on the anterior teeth of the lower jaw, and produced the destructive action that resulted in the deplorable loss of tooth-substance shown in Fig. 763.

"The prosthetic devices thus briefly described have so far proved perfectly satisfactory to both patient and dentist. The obvious difficulties of the case, and the somewhat novel means employed in supplying useful and secure dental substitutes, seem to justify the writer in bringing the case to the attention of the profession."

FIG. 765.

A bridge of this form can also be made removable by cementing it on the natural crowns or roots with gutta-percha, and by still further securing it by screws entering the body of the crowns or roots through the gold forming the occluding or grinding surface portion.

Dr. H. C. Register has devised the following method, which, in the event of a porcelain crown being broken, possesses the advantage of allowing the place to be filled by a new crown without disturbing the main appliance. The following concise description of this method is by Dr. Dexter:—

"Taking a typical case (Fig. 766), a rim or saddle of gold, platinum, or iridinized platinum is struck to fit the spaces between the

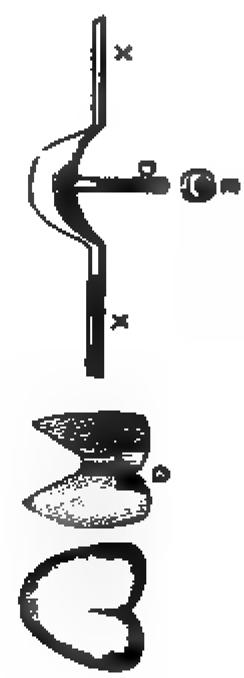
teeth A and B. To this are attached bars, X, Fig. 768, to enter the fillings at Z, Z (Fig. 767). Posts or pivots (D, Fig. 768) are soldered upon this saddle where the artificial teeth are to be placed, their

FIG. 766.

free ends being threaded to carry the nut E. Hollow crowns, countersunk for the nut at G, and having the necks ground to reach over the saddle and press upon the gum, are fitted over each post.

FIG. 767.

FIG. 768.



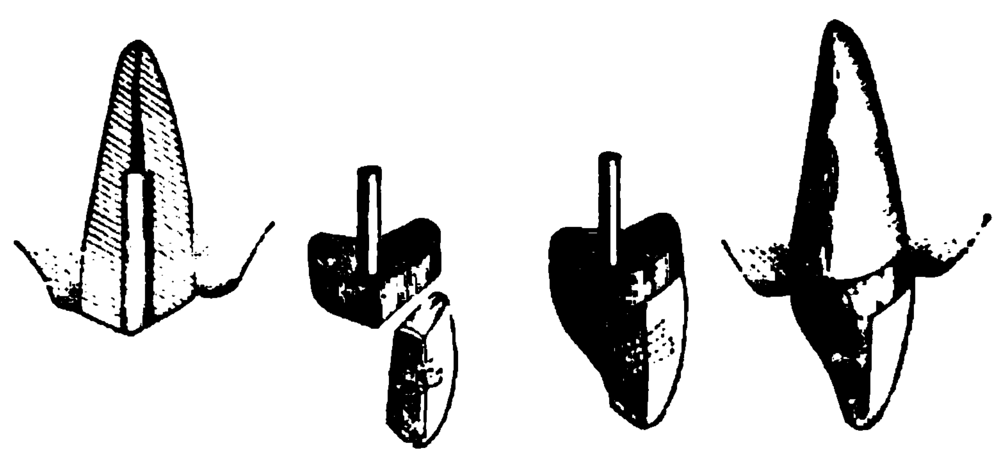
Amalgam is used to fill in the space between the post and the tooth-wall, as in a Bonwill setting, and the crowns are drawn to place and held with the nut. The saddle is fixed in its place in the mouth, before the crowns are finally attached, by filling into the cavities Z the bars X X."

Dr. J. L. Williams suggests the following methods for the single crown and for "bridge-work," which he describes as follows:—

"It consists essentially of three parts: a square pin of platinum and iridium which enters the enlarged pulp-canal, a cap of gold, and the porcelain face, which is the ordinary plate tooth.

"This crown is made in the following manner: After the end of the root is made perfectly smooth with corundum wheels and properly shaped scalers, a gold ferrule or band is fitted around it. If it is desirable that this band should be entirely concealed, the labial surface of the root should be beveled a little above the margin of the gum, and after the band has been soldered it may be placed in position, and the line of contour of the margin of the gum marked upon the front of the band. The proper bevel can then be cut and the edges squared upon a corundum wheel, leaving the

FIG. 769.



lingual portion of the band a little longer than the front. Pure gold, rolled to No. 34 of the standard gauge (American), is used for soldering upon the beveled surfaces, thus making a closed cap for the end of the root. A suitable tooth is now selected and backed with pure platinum or pure gold. The cervical end of the tooth is then ground to the proper position on the front bevel of the cap, all of the fitting being done while the cap is in position on the root.

"After the fitting is completed the cap is removed and the tooth attached by strong resin wax and again placed in position while the wax is warm. Any slight change in position which is necessary can then be easily made. The tooth and cap are now removed together, invested, and united at the back by solder. It is well to use a solder for the cap with a higher melting point than that used for the backing, as it obviates the danger of unsoldering the band when the backing is flowed on. After finishing and polishing the work, the end of the root is made perfectly dry, a sufficient quantity of oxyphosphate cement, mixed somewhat thinner than for filling purposes, is placed in the enlarged pulp canal and also in the cap. The crown is then carried to place with firm, steady pressure, held

a few minutes until the cement is sufficiently hard to prevent displacement. The surplus cement which has oozed out around the band should be carefully removed, and the work is then completed."

FIG. 770.

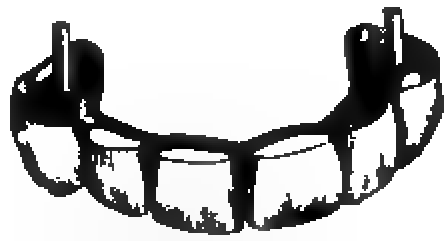


FIG. 771.

FIG. 772.

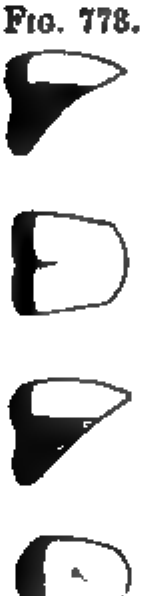


FIG. 773.

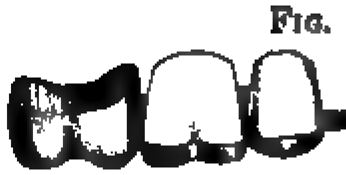


FIG. 774.

Dr. Williams's method can be applied to "bridge-work," as the above Figs. 770, 771, and 772 will show.

In this method, special crowns, Figs. 773 and 774, for molars and

bicuspids, with porcelain faces, are made, which are backed with gold or platinum and the tips ground squarely off. Zinc pattern dies are made from the grinding surfaces of molars and bicuspids, to be used for swaging from pure gold a tip or cap for the protection of the porcelain face. The concave surface of these tips is filled by melting coin gold into them, and this surface is then ground smooth and fitted to the squared surface of the porcelain face and waxed into position. Triangular pieces of platinum are then cut of the proper size to fit the sides of the tooth, waxed in position, and the whole invested, leaving the back open, which is filled with coin gold.

Dr. Williams also describes other forms of bridge-denture, in one of which there are no supporting roots, and in the other the sections are united by bands of gold.*

"Figs. 775 and 776 illustrate a method of inserting extensive pieces of bridge-work in cases where there are no natural teeth

Fig. 776.

or roots for supporting one end of the bridge. The work from which these drawings were made was constructed by Dr. H. A. Parr. By this method bridges may be inserted in cases where all of the teeth on one side of the mouth have been lost, or where all the teeth anterior to the molars on both sides are wanting. Crowns are first fitted to the teeth which remain. These crowns being in position, an impression is taken. From this a cast is obtained with the crowns in their proper positions. A second impression is also taken of that portion of the mouth where there is no natural support for the bridge. From this impression metallic dies and counter-dies are obtained, from which is 'struck' a

* *Dental Cosmos*, December, 1885.

small gold plate about three-fourths of an inch in length and width, the size of the plate varying according to position and other conditions. After this little plate or 'saddle' has been perfectly fitted, it is waxed in the proper position on the model, with the crowns. The intervening teeth are now placed in position, and the work invested

Fig. 776.

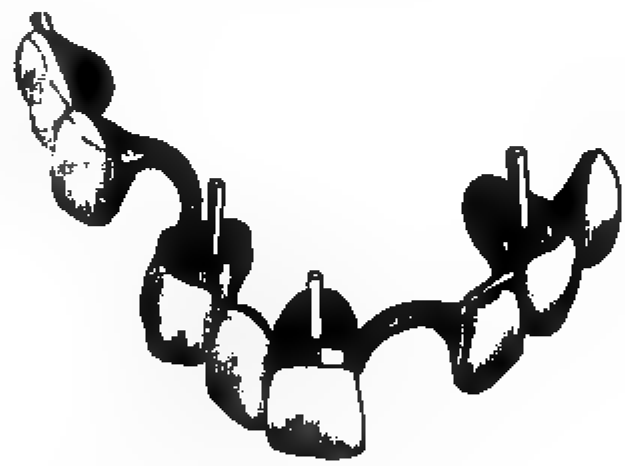


Fig. 777.

and soldered. To provide for the possibility of shrinkage or absorption at the point where the plate or saddle rests, it is suggested that it be not soldered to the bridge, but attached by means of an adjustable screw.

"Fig. 777 illustrates another device for obviating the necessity for removing the crowns of natural teeth in preparing the mouth for

Fig. 778.

bridge-work. Crowns are fitted in the mouth to the points of attachment in the usual manner. An impression is taken, bringing the crowns away in their proper positions. From this the cast or model is obtained. Heavy bands of half-round gold or platinum bars are

now fitted around the necks of the natural teeth, on their lingual surfaces. These bands, being waxed in position, serve to connect the different parts of the bridge, uniting them in one piece without the loss of any of the natural crowns. I have found this a highly satisfactory method of inserting extensive pieces of the work. Fig. 778 shows the mouth as presented, for which the piece shown in Fig. 777 was constructed. Fig. 779 shows the piece in position.

Fig. 779.

"Fig. 780 illustrates a case which is a type of a class of frequent occurrence. Alternate molars and bicuspids in the upper and lower jaws are lost until the occlusion is somewhat changed, and the force of mastication is gradually brought upon the front teeth.

Fig. 780.

Fig. 781.

Rapid wearing of these teeth results. These cases are among the most difficult that the operator is called upon to treat by the ordinary methods. In the case herewith illustrated, the lower bicuspids with a molar on one side were in good condition, but the loss of the upper bicuspids and molars made them useless. As usually

happens, the upper incisors had suffered most. The lower incisors were restored by capping them with cohesive foil. The bridge shown at Fig. 781 was constructed for the right side of the upper jaw, while the teeth on the left side were restored by contour work, as shown at Fig. 782.

"The superiority of the condition of this patient's mouth, which resulted from this work, over anything which could have been accomplished by plate work, is almost inconceivable to one not familiar with these methods.

"The only annoyance which bridge-work is likely to cause patient or operator is the occasional breaking of a porcelain, an accident of not frequent occurrence. While the replacing of a broken porcelain has never been a matter of extreme difficulty, yet I have always regarded the methods hitherto employed as more or less imperfect and uncertain in their results. This led me to devise a method of

FIG. 782.

FIG. 783.

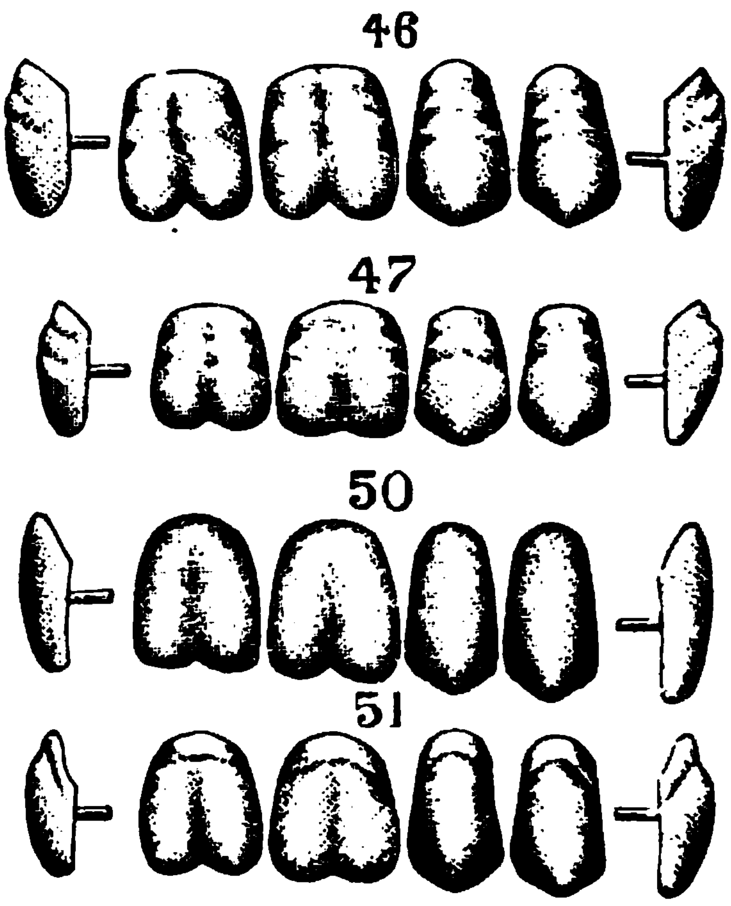
replacing broken porcelains which leaves the work fully as strong as before; a method which makes the operation a very simple one, requiring less than an hour for its performance; and after the porcelain has been replaced, an expert would not discover any traces of an accident. After removing all traces of the broken porcelain, the projecting pins are cut off, and two holes drilled through the backing in the exact position occupied by the pins. The narrow space of metal now intervening between these two holes is cut out with a fissure-burr. This leaves a groove which should not be wider than the diameter of the pins. The length of this groove should now be increased on the lingual surface, but not on the front. The object of this is to give a dove-tail shape to the groove, which is easily effected by the use of the same fissure-burr above referred to. The lingual appearance of this groove when properly shaped is shown in Fig. 783. The proper tooth is selected, the pin passed through this hole and bent outward into the dove-tail groove. It now remains but to fill the space between the pins with any form of cohesive gold (I use crystal gold), and with corundum, Arkansas, and rubber points in the

engine the surface is finished and polished. The wedge-shaped filling of crystal gold acts as a keystone between the pins, and makes a most perfect method of repair."

Porcelain veneers or facings for bridge-work are represented by Fig. 784.

These facings of molar and bicuspid forms have two long platinum pins (cross-wise) for attachment. They are specially designed for use

FIG. 784.



in bridge-work operations. The long pins afford facility of repair when a tooth has been broken in use. Incisor facings of the same character are also employed.

Dr. H. W. Howe recommends the following flux that is exceedingly useful in bridge-work, and is prepared as follows. Put in a cup:—

Boracic acid,	1 oz.
Ammonia,	½ oz.
Carbonate of ammonia,	½ dwt.
Bicarbonate of soda,	2 dwt.
Water,	4 ozs.

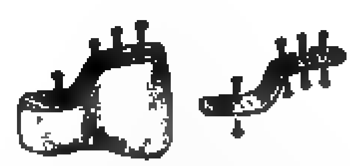
Boil until the fumes of ammonia are no longer given off. Coat the bridge or other work all over the gold with the flux. Heat it over a spirit-lamp to dry it on. Give it another coat, if needed, leaving no part exposed. Then scrape off where it is desired that the solder shall flow, and it will go nowhere else. The work will come out of the heating as bright as when it went in, and the solder will be smooth. The polished surfaces will not be corroded or blackened.

Dr. C. H. Land has devised what he calls "metallic enamel coatings and sections," which he describes as follows :—*

"The accompanying engravings, Figs. 785 and 786, are taken from practical cases that have at this date been in use for one year. In the case represented by Fig. 785, the patient was about sixty years of age. The right lateral incisor was prepared with a Howe post, shown in its relative position. The five remaining teeth, after the cavities were prepared, contained tooth substance as represented by the dark surfaces, the white representing the lost portion of each tooth, restored with sections of porcelain made to imitate the exact color and contour of the original tooth substance. The cavities are prepared as for gold filling, when a thin piece of annealed platinum plate, No. 35 standard gauge, is placed over the tooth, and by

FIG. 785.

FIG. 786.



means of burnishers made to take a perfect impression of the outer rim of the cavity, after which platinum pins are attached, as shown at A. The object of the pins is to serve as a fastening, both for the porcelain paste or body and as retainers to hold the completed section in the cavity of the tooth. The porcelain paste or body is built upon the platinum disk and made to imitate the lost portion of the tooth. It is then baked in a gas furnace, requiring but twenty minutes for the first biscuit and fifteen for the second, and when finished appears as shown at B, ready to be cemented with oxyphosphate. C and D are modifications for the other teeth, and Fig. 786 illustrates porcelain facings for molars.

"The especial feature of this system is the large amount of tooth substance preserved above the gum, there being no necessity for telescoping the root so far below as to sever the tissues. This mode of practice also dispenses with the long operations and protracted use of the rubber dam; it almost entirely obviates the use of amalgam, and saves the necessity for large gold fillings; there is

*_Independent Practitioner_, February and August, 1887.

no malleting, no long and tedious operation either for the patient or dentist, while at the same time teeth are perfectly restored, both in appearance and usefulness.

"There is another advantage in the use of the enamel coatings which is not, in my opinion, a trivial matter. When large metallic fillings are inserted, the constant thermal changes consequent upon their alternate heating and cooling must exercise an unfavorable influence upon the tissues about the tooth. Even if the pulp be dead and the root be filled, there will be a checking and fracture of the tooth in time, from the continually varying changes of temperature. An inflammation of the membranes will also be likely to occur from the same cause, and thus the tooth will in time be lost, from the mere influence of the presence of a large mass of metal.

"It is also a fact that large gold fillings cannot be inserted without so much malleting that the strength of the tooth is gone, and frail walls are cracked beyond the possibility of repair. These dangers are all obviated by the use of the porcelain facings, while teeth so restored are much more natural in feeling and more grateful to the touch of the tongue than any metallic filling can be."

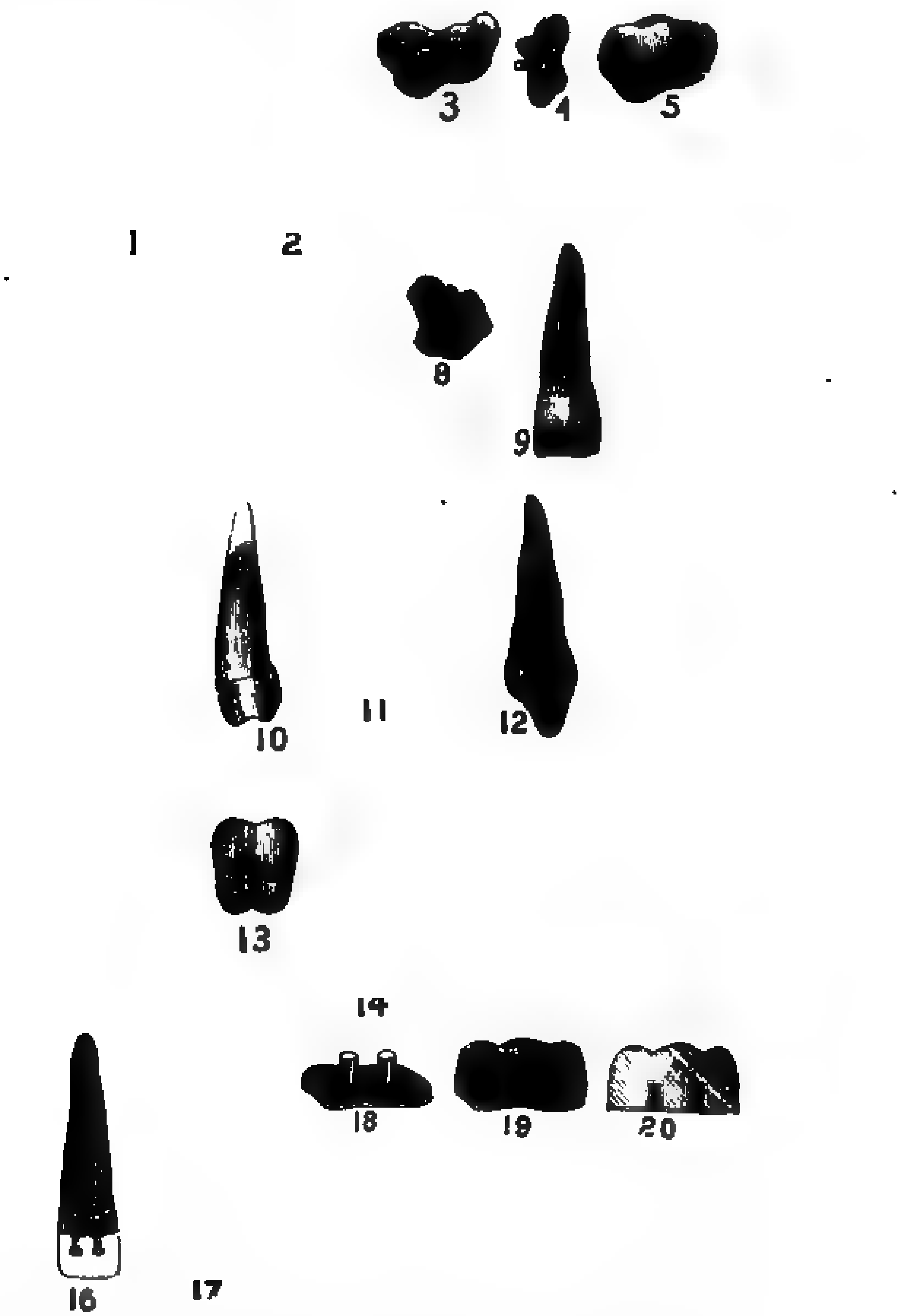
Dr. Land describes his metallic enamel sections as follows:—

"By reference to Fig. 787, Nos. 2, 7, 10, 12, and 15, there will be seen characteristic conditions of decay suitable for this class of work. 2 and 7 are the prepared cavities on anterior sides of molars. The manner of procedure is to burnish a thin piece of annealed platinum plate into the cavity. This takes a perfect impression of its outlines. The surplus edges are trimmed off and platinum pins attached, using pure gold leaf for solder. (See 3 and 4.) The pins serve as a fastening, both to secure the completed section in place and as retainers for the porcelain body. 5 and 8 illustrate the completed sections, showing the contour of the original shape of the lost portion of the natural tooth. Nos. 1 and 6 are prepared sections cemented in place.

"Having secured the prepared sections as shown in 3 and 4, porcelain paste or body is built upon them and carved so as to imitate the original contour of the lost portion of the tooth, as shown in 5 and 8. They are then placed on a bed of silex and fused in a gas furnace. This requires twenty minutes for the first biscuit, and fifteen for the second. When completed, they will be a reproduction in porcelain of the lost parts of the natural organs, resembling nature perfectly, both in color and shape. They are then cemented in the cavity, either with gutta-percha filling or oxyphosphate cement. When the anterior side of a molar or bicuspid is decayed, as shown in 11 and 15, the enamel front or veneer, 13, is added to

the porcelain body, and when completed it will appear as shown in 14. This veneer serves as a ready and efficient means of securing

FIG. 787.



the proper shape and contour of each class of teeth. To those who are not familiar with the use of a gas furnace this class of work may

seem difficult, but a little experience with the modern appliances now within the reach of every dentist makes the operation a comparatively simple and easy one. 17, 18, 19, and 20 are a modification. 17 represents a tooth filled with gold, having two pins attached. 18 is a platinum disk, with tubes adjusted to correspond to the position of the pins in 17. Porcelain body is built about the tubes, and when fused in the furnace the whole will form a porcelain crown, as shown in 19. 20 illustrates the relative position of the tubes, which are designed to form countersinks for the pins in 17. When cemented in place, it makes a very durable and beautiful piece of work. 16 is an incisor constructed in a similar manner. From this will be seen the great advantage of being able to have the porcelain in a plastic state, as it enables the dentist to perfectly adapt the form of each peculiar case with the utmost precision, and this could not be so admirably done with manufactured crowns.

Fig. 788.

Fig. 789.

"I wish to call especial attention to the large amount of tooth-substance preserved. In nearly all the modern systems of crown-work there seems to be too much good tooth-material cut away, and I think a careful investigation will demonstrate this new process to be far superior, making it possible to save the greater portion of the crown, it not being necessary to cut beneath the gum. In nearly every case, sufficient tooth-substance can be retained to preserve the pulp alive, and when the teeth are devitalized the major portions of the crown can be left intact, serving for retaining purposes and making it unnecessary, in the majority of cases, to resort to screws or posts. 16 illustrates a section of porcelain adjusted to a central incisor which, when carefully done, makes a very acceptable piece of work. Although the joint may sometimes be conspicuous, it is not nearly as much so as a glaring piece of gold."

Figs. 788 and 789 represent a practical case before and after the insertion of the sections.

In concluding the subject of artificial crowns attached to natural roots and teeth, it remains only to briefly refer to the advantages

and disadvantages of each method. As regards what is strictly pivot work, all methods are objectionable in which the exposed surface of the root is not protected from such agents as disintegrate tooth structure; as regards the ferrule or band crown, such work is objectionable where it causes irritation of the gum and periosteal tissues, or permits of the disintegration of the supporting roots or teeth, or is temporary in its nature, on account of the use of the plastic preparations in connection with it; and lastly, all "bridge" or "graft" work is objectionable where it cannot be kept perfectly clean and free from accumulations of fluid and other substances beneath it, and where it cannot be repaired in case of accident without breaking up the entire appliance. The effects of thermal changes on tooth tissues when brought directly in contact with large masses of metal, and the exceedingly frail nature of many of the porcelain crowns and facings required by some of the methods in use, should also be considered.

FIG. 790.

1 2 3 4 5 6 7 8

FIG. 791.

9 10 11 12 13 14 15 16

To grind the Logan tooth-crown, it has been suggested to take a hollow mandrel and, while in a hand-piece, heat the end and mount on it a corundum wheel, such as No. 00, being careful to make its outer face true and leave the hole in the end of the mandrel free for the pivot or post of the tooth-crown to enter. The neck of the Logan crown can then be ground without the risk of grinding the post or pivot, which enters the socket of the mandrel and is protected.

Solid gold cusps made of twenty-two carat gold and designed to

be soldered to gold bands fitted to natural roots, and also for forming the masticating surfaces of porcelain crowns in bridge-work, can be obtained at the dental depots or be made by stamping thick gold plate with hard metal dies.

Figs. 790 and 791 represent gold cusps for crown and bridge-work.

CHAPTER VI.

MANNER OF REFINING AND ALLOYING GOLD, AND CALCULATING ITS FINENESS.

GOLD is the best metal, and for general use the best material, that can be used for the attachment of artificial teeth. When used of proper fineness it resists the most acrid secretions of the mouth, and undergoes, during the long years of use, no change in its strength, form, or texture. Other metals and materials have a special utility, but none have so wide a range of usefulness, and none can take the place which this royal metal holds in dental prosthetics.

Although the manner of refining, alloying, and manufacturing gold into plate, solder, etc., may not, perhaps, be regarded as coming properly within the province of the dentist, yet, as he often experiences great difficulty in procuring them of the right quality, a brief description of these several processes is necessary. Especially is this necessary, since the dental depots seldom keep on hand any gold plate finer than eighteen carats. This we consider discreditable to the profession which calls for so inferior a quality of metal, rather than to those whose business it is to supply their demands. Twenty-carat plate can as readily be kept on hand by manufacturers as twenty-four carat foil. Moreover, some practitioners are so situated that they cannot use gold plate, unless they know how to prepare it from coin.

Gold in its pure state, free from alloy, is too soft and yielding to serve as a suitable support for artificial teeth; but if it contains too much or an improper alloy, it will become tarnished by the secretions of the mouth, rendered too brittle for service, through those molecular changes which take place, with greater or less rapidity, if the plate is less than twenty carats fine. It is, therefore, of the utmost importance that the gold used in connection with artificial teeth should be of the proper fineness, and possessed of the requisite malleability. To secure these qualities, it is necessary to know the

kind and quantity of metal with which to alloy it before it is made into plate or other forms necessary for the purposes for which it is to be employed.

Gold clippings, filings, and other scraps and parts of old gold pieces, as found in the laboratory, are apt to become mixed with base metals, such as iron from the wearing of files, and occasionally small particles of lead, tin, or zinc. If these are melted with and permitted to remain in the gold, they will destroy its ductility, and render it unfit for use. Iron, less objectionable than the lead or tin, may always be removed with a magnet before the gold is melted; but to free it perfectly from the others, it will sometimes be necessary to refine it in the manner presently to be described. A two-thousandth part of tin or lead destroys the ductility of gold, and even exposure to the fumes of red-hot tin or lead renders it exceedingly hard and brittle. Antimony, or bismuth, when mixed with gold, exerts upon it a very similar effect. So marked is the influence of antimony in injuring one of the most valuable properties of gold, that its original name, *regulus* (little king), by which it is best known in commerce, was given in view of this controlling effect upon the king of metals. It is of the utmost importance to bear in mind the action of minute quantities of these four metals, so much used in the laboratory, upon gold, platina, and silver.

Platina, united with gold in certain proportions, has the effect of hardening the latter metal and making it very elastic, but does not materially affect its ductility. The affinity of the alloy for oxygen, however, is so great that it is readily acted on by nitric acid. The acids of the mouth will often make this alloy very brittle. But for this, the two metals, combined in the proportion of the fifteen parts of gold to one of platina, would form an exceedingly useful alloy for the construction of spiral springs. That a combination of two metals should be thus easily acted on by an agent incapable of acting on either when in a separate state, may appear somewhat remarkable, but it is, nevertheless, true. We have in the effect of platina upon steel an analogous case. It makes the steel exceedingly hard and fine-grained; but although itself totally insensible to the action of oxygen, when alloyed in minute quantity with steel, it causes this latter metal to oxidize with such readiness as to make it unfit for use.

Hence may be seen the fallacy of the idea entertained by many, that because platina is a more destructible metal than silver or copper, it must necessarily make a purer plate. The properties of alloys are, in fact, so often and so widely different from those of their component metals that they can be ascertained only by experi-

ment. Of the three metals, platina, silver, and copper, speculative theory might select the first and purest as the best alloy for gold; whereas, actual experience demonstrates that copper, itself the most injurious to the mouth, imparts most perfectly to gold, if kept within proper limits, those qualities which are required in a dental plate.

In view, then, of the importance of having gold which is to be placed in the mouth of the right quality, every dentist who has connected with his practice a mechanical laboratory should have the necessary fixtures for melting and working this metal into the various forms required for dental purposes. The principal of these are, a small furnace, with crucibles and tongs, ingot-moulds, an anvil and hammers, and a rolling mill; a plate gauge, draw plate, and bench vise; fluxing and refining chemicals, etc.

REFINING GOLD.

It is not our intention, in describing the manner of refining gold, to enter into a minute detail of the various methods employed for assaying or refining this metal, but to point out as briefly as possible the manner of separating it from the several metals with which it is most frequently combined in the dentist's laboratory.

The method usually employed by assayers for separating gold from silver is to roll the alloy out into very thin plates, and put it in nitric acid; this will dissolve most of the silver, and leave the gold behind in the form of brown plates, scales, or powder, which, after being thoroughly washed, is put into a crucible with borax and melted down into an ingot of pure gold. But this method will not succeed unless the quantity of silver be equal to two or three times that of the gold; for the nitric acid, which acts only upon the silver (and copper), cannot eat out all the alloy if its particles are too much surrounded with the particles of gold. From the old rule—one-fourth gold, three-fourths alloy—came the name given to this process, *quartation*; it is also known as the *nitric acid* process. It is well adapted to the purification of gold upon a large scale, and is the process used in the U. S. Mint. But it does not remove the platina so generally found in dentists' scrap; and is not so well adapted for gold of 18-carat fineness and upward as the next process.

The nitro-muriatic or *aqua regia* process dissolves all the metals of the alloy, but immediately precipitates the silver. The gold is subsequently precipitated in a state of purity, thoroughly washed, dried, and melted down with borax. The process is, briefly, as follows: Melt the scrap to be refined; roll into a thin strip and curl it up into what is technically termed a *cornet*; place in a porcelain

vessel and pour on the aqua-regia, three or four ounces to the ounce of alloy, which must be mixed at the moment of using, in the proportion of one part of pure nitric acid to two, two and a half, or three parts of hydrochloric acid; quicken the solution by heat from a spirit-lamp, setting the vessel where the nitrous fumes can escape from the room; decant or filter the solution so as to separate the precipitated silver; evaporate the clear solution over a spirit-lamp, nearly to dryness, add hydrochloric acid, and evaporate a second time, so as to get rid of all nitric acid.

The concentrated orange-colored solution is the chloride of gold together with the chloride of platina and other metals, from which it must be separated by precipitation. Dilute largely with water, and add, little by little, a solution of the protosulphate of iron (green-vitriol), until the dark olive-brown precipitate, which instantly appears, ceases to form. Pour on this precipitate some sulphuric acid, to remove all traces of iron, and then wash several times with hot water, dry it, and melt with borax in a crucible.

If the presence of much platina is suspected, the solution should be treated with muriate of ammonia (sal ammoniac) after the gold has been removed. This will precipitate the platina, which should be washed, dried, and sold, inasmuch as the dentist has no heat sufficiently intense to melt it. If the alloy to be refined consists simply of gold and platina, the aqua regia solution, after being made neutral by twice evaporating nearly to dryness, should be diluted with water and the platina precipitated by muriate of ammonia; then decant the gold solution from the platina and precipitate the gold by the proto-sulphate of iron.

A third method of refining is the *sulphuric acid* process, which it is unnecessary to describe further than to say that it resembles the *quartation* process. Gold is melted with five to seven times as much silver, granulated, and then boiled three or four hours in a platina or iron retort with sulphuric acid.

By any of these three processes, but most conveniently by the second, dental scrap may be refined to a purity sufficient for every practical purpose. The assayer resorts to other methods to obtain the absolute purity required in analyses.

Gold still containing traces of silver may be treated with sulphuret of antimony. This is done with a strong heat in a covered crucible, and after the gold has been kept in a state of fusion for some thirty or forty minutes it should be poured into an ingot-mould and separated from the antimony, which will lie at the top. It may be necessary to melt it in this way two or three times, adding, each time, a less quantity of antimony; at the last melting, a current of

air from a pair of bellows should be thrown upon the surface of the fused metal, to evaporate the antimony, and after the vapor ceases to escape, a little refined nitre and borax should be thrown into the crucible. It should then, in a few minutes, be poured into the ingot-mould; should it crack in hammering or rolling, it must be again melted, and a little more nitre and borax thrown on it.

Still another process for refining gold is occasionally used, called cementation. It consists in first rolling the gold out into exceedingly thin plates, then placing it in a crucible with a mixture of four parts of brickdust, one of calcined sulphate of iron, and one of chloride of soda. A bed of this mixture or cementing powder is first placed in the bottom of the crucible; the gold is then put in and covered with it. The crucible is covered with another crucible, the joints well luted with clay, and gradually raised to a red heat, at which temperature it should be kept from twenty to twenty-four hours. The crucible is then removed from the fire, the top broken off, and after it has cooled the gold may be separated from the cement and washed, or, what is still better, boiled in hot water.

The form of furnace for melting gold depends much upon the kind of fuel. Charcoal, coke, and anthracite are the three kinds used; bituminous coal is inadmissible until converted into coke. The plumbing stores and stove factories now furnish so many convenient forms for the use of gas, and any of these fuels, that we shall not occupy time or space in their detailed description. A pipe six feet high will give to the ordinary "preserving furnace" a draft sufficient to melt gold with charcoal; coke gives a very intense heat, but needs a stronger draft; anthracite requires a powerful draft, but gives a more steady heat, needs less frequent renewal, and hence is better for long-continued heats.

As regards the shape and size of the stove, the following points should be attended to: convenience of access to the crucible; sufficient depth and width to surround the crucible with a good body of fuel, without unnecessary waste of material.

Fletcher's small and convenient blast crucible furnaces, for melting gold by the use of gas and refined petroleum, are very serviceable in laboratory work.

The Ceylonese goldsmiths use a blast furnace of very rude and simple construction. It consists of a small, low, earthen pot, filled with chaff or sawdust, on which a little charcoal fire is made, which is excited with a small bamboo blowpipe about six inches long, the blast being directed through a short, earthen pipe or nozzle, the end of which is placed at the bottom of the fire. By this simple con-

trivance, a most intense heat may be obtained, greater, it is said, than is required for melting gold or silver.

For separating iron, copper, tin, lead, or zinc from gold, the following simple method may be adopted: After passing a magnet a number of times through the filings or fragments, to remove all traces of iron or steel, put the gold in a clean crucible, covered with another crucible, having a small opening or hole through the top; lute the two together with clay; place them in a bed of charcoal in the furnace; ignite the coal gradually; afterward increase the combustion by means of a current of air from a pair of bellows, or by turning on the draft; after the gold has melted throw in, at intervals of about ten minutes, several small lumps of nitrate of potash (saltpetre) and sub-borate of soda (borax), and keep it in a fused state for thirty or forty minutes; then remove the crucible, and plunge in water to cool it; break it and separate the lump of gold from the dross; then put into another crucible; melt with a little borax, and pour into an ingot-mould of the proper size, previously warmed and oiled. Bichloride of mercury (corrosive sublimate) is sometimes used instead of or after nitre, for the purpose of dissipating the base metals, and often with more certain and better results, especially where the presence of any tin is suspected. If the gold cracks on being hammered or rolled, it should be melted again, and more nitre and borax thrown in; the inside of the crucible should also be well rubbed with borax before the metal is put in. It is sometimes necessary to repeat this process several times, and if the gold still continues brittle, a little muriate of ammonia (sal ammoniac) may be thrown into the crucible when the gold is in a fused state; after the vapor ceases to escape, the metal should be poured into an ingot-mould, warmed and oiled as before directed. This last method of treatment will make the gold tough, and prevent it from cracking under the hammer or while being rolled, provided it is from time to time properly annealed during the process.

By this method of refining gold, known as the *dry process*, or "refining by fire," sufficiently accurate results will be obtained for many of the practical purposes of mechanical dentistry, since the variation of an eighth or a quarter of a carat in the fineness of gold plate is not often a matter of much consequence. Comparing the two classes of refining processes—the *humid*, by acids, and the *dry*, by fire—the first is the most accurate, and the only way to remove platina or silver; but it is the most troublesome, and requires a familiarity with chemical details, which, unfortunately, many dentists are totally ignorant of. The second may remove the lead, tin, zinc, antimony, and bismuth, if in small quantity; and if continued

for a sufficient length of time, with a free use of nitre, may remove a large proportion of copper. It can scarcely be depended upon if the object is to make an ingot of pure gold, but will answer admirably if the purpose is merely to lessen the alloy or remove certain impurities.

As the dry process is one that the dentist will often have occasion to resort to, we shall give (from the seventh volume of the *American Journal of Dental Science*) the following description of the very excellent method pursued by Dr. Elliott, of Montreal:—

"The following implements are necessary for this purpose: a small draught furnace; a quantity of fine hard-wood coal; a clean crucible, with a sheet-iron cover (a lump of charcoal is better); a light pair of crucible tongs; an ingot-mould, made of soapstone; a little nitrate of potash, carbonate of potash, borax, and oil. The fireplace of the furnace should be about ten inches in diameter and eight or ten deep; this should be connected by means of a pipe with the chimney, so that a powerful draught may be made to pass through the coal. A blast-furnace is objectionable, for the reason that the bellows burns out the coal immediately under the crucible, and it is, therefore, constantly dropping down, which is not the case with the draught furnace; besides, the draught furnace produces a more even fire, a quality equally indispensable.

"In preparing for a heat, the furnace should be filled about half full of coal, and after it is well ignited it should be consolidated as much as practicable without choking the draught. The crucible containing the metal and a little borax may then be set on, and more coal placed around and over it, the door of the furnace closed, and the damper opened. It should remain in this way until the gold is perfectly fused. The coal may then be removed from over the crucible, and a bit of nitrate of potash dropped in, in quantity equal to the size of a pea to every ounce of gold, and the crucible immediately covered with a plate of iron. More coal may then be placed over and around the crucible, and the gold kept in a fused state at a high temperature, until the scoria ceases to pass off, which it will do in the course of five or six minutes. The ingot-mould, having been previously warmed, should be placed in a convenient position for pouring, and filled about half full of lamp oil. The cover should now be thrown off quickly, the crucible seized with the tongs, and at the same instant another small bit of nitrate of potash should be thrown into it, and the gold rapidly, but carefully, poured into the mould.

"The ingot always cools first at the edges, and shrinks away from the middle. On that account, the mould should be a little concave

on the sides, so that the shrinking will not reduce the ingot thinner in the centre than at the edges.

"Moulds of the best form will sometimes produce ingots of irregular thickness. Such ingots should be brought to a uniform thickness under the hammer, using the common callipers as a gauge. If this be neglected, the plate will be found imperfect at those points where the ingot was thinnest. The plate should be annealed occasionally during the process of hammering and rolling, and should be reduced about one number in thickness each time it passes between the rolls. If any lead, tin, or zinc be mixed with the gold, the nitrate of potash must be used in much larger quantities, and, in that case, it is better to let the button cool in the bottom of the crucible. Then break the crucible and melt it in a clean one for pouring, using borax and nitrate of potash in very small quantities for the last melting.

"In case the subject of assay be in the form of filings or dust, a magnet should be passed through it, so as to remove every particle of iron, and then, instead of melting it with borax, it should be melted first with *carbonate* of potash, and afterward with *nitrate* of potash, in quantities proportioned to the necessities of the case, as before directed. Carbonate of potash is the only flux that will bring all the small particles of metal into one mass. Without it, a great portion of the gold will be found among the scoriæ, adhering to the sides of the crucible, in the form of small globules. This process of refining answers equally as well for silver as for gold."

ALLOYING GOLD.

Gold, when in an unalloyed or pure state, as before stated, is too soft to be used as a support for artificial teeth; consequently, it has been found necessary to combine with it some other metal, in order to harden it. Silver and copper are the alloys most frequently employed. Many dentists prefer the former, erroneously supposing that it does not increase the liability of gold to tarnish as much as the latter. But this opinion is sustained neither by facts nor experience. Gold, when alloyed with copper, unless reduced altogether too much for dental purposes, will resist the action of acids as effectually as when alloyed with silver, and the former renders it much harder than the latter. Besides, it renders the gold susceptible of a higher and more beautiful finish. If, therefore, but one of these metals is used, copper may be regarded as preferable to silver.

The gold employed in mechanical dentistry by most practitioners is altogether too impure for the purpose, it being not more than

eighteen carats fine, and sometimes it is reduced even to fourteen When not above these standards of fineness it is discolored by the buccal secretions, imparts a disagreeable taste to the mouth, and becomes brittle after it has been worn for a few years. The plate which is to serve as a basis for artificial teeth should never be reduced below twenty carats; and as that for the upper jaw does not require to be more than one-third or one-half as thick as that of the lower, the gold for the latter may be a little finer than that employed for the former, as it is necessary that it should be more malleable. The following standards of fineness may be regarded as the best that can be adopted for gold used in connection with artificial teeth: plate for the upper jaw, twenty carats; for the lower, twenty-one; and for clasps and wire for spiral springs, eighteen.

In reducing perfectly pure or twenty-four carat gold to these standards, first make an alloy of copper and silver, which may be either in the proportion of copper 4, silver 1, or copper 9, silver 1, according to the qualities required in the plate. The effects of the two metals are in strong contrast—copper giving hardness and elasticity, and deepening the color into a red; silver preserving the softness, and giving a greenish-white shade to the original yellow of the pure gold. Of these alloys take—to twenty-one grains of pure gold, three grains; to twenty grains of pure gold, four grains; and to eighteen grains of pure gold, six grains; to make, respectively, twenty-one, twenty, and eighteen-carat gold. In the latter case, the alloy should be used containing most silver, as so large a percentage of copper makes the gold too hard and elastic, and gives it rather too red a color.

The gold should be first melted in a clean crucible, and as soon as it has become thoroughly fused, the silver and copper alloy may be thrown in, with two or three small lumps of borax. After keeping the whole in a melted state for some five or ten minutes, it should be quickly poured into an ingot-mould of the proper size, previously warmed and oiled. If the gold cracks during the process of hammering or rolling, it must be melted again and a few small pieces of borax with a little muriate of ammonia thrown in, and in five or ten minutes recast into an ingot.

When scraps and filings are to be converted into plate they should first be refined, afterward properly alloyed. This may also be necessary with all gold the quality or fineness of which is not known; but with national coins having a known fixed standard this will not be necessary. When they are above these standards of fineness, the amount of alloy necessary to reduce them to the required fineness may be readily found by calculation. It is often unnecessary

to change the fineness of either American (21.6 carat) or English (22 carat) coin; especially when the depth of the plate in upper cases, or the prominence of the ridge in lower, gives additional stiffness to the plate.

There are two principles upon which plates are alloyed. The first, and common one, is to add as much alloy as the gold will stand; the second is to add the least possible quantity. The first results in eighteen-carat gold, and uses mainly silver, lest the six grains of alloy should make it too brittle. The last results in twenty or twenty-two-carat gold, and uses chiefly or exclusively copper, since the least quantity of this gives the greatest stiffness.

The simple rule is to have the purest plate which the form of the mouth will permit. For shallow mouths, requiring increased stiffness, a twenty-carat plate may be used; but better practice still is to increase the rigidity by greater thickness, or sometimes by doubling some part of the plate.

In connection with the alloying of gold, it is proper to make some remarks upon the terms in which the fineness of alloys is expressed, and the means of ascertaining it.

Pure gold being taken as the starting-point, it may be expressed by unity (1), or by 24, or by 1000. In the first case, fineness is given in *fractions*. In the second case by parts called *carats*, which, for convenience, may be considered as equivalent to a grain; thus representing pure gold by 24 grains, or 1 dwt. In the third case, value is expressed in *decimals*, and is the most convenient system, although the second is the most customary with jewelers and dentists.

The following table, prepared by the late Prof. Austen, will show the relative value of these three systems in a few of the most usual forms of gold alloy:—

	FRACTIONS.	CARATS.	DECIMALS.
Pure gold	1.	24.	1000.
English coin	$\frac{11}{12}$	22.	916.6
American coin	$\frac{9}{10}$	21.6	900.
Dentists' gold, best	$\frac{5}{6}$	20.	833.3
" " good	$\frac{4}{5}$	19 2	800.
Jewelers' gold, best	$\frac{3}{4}$	18.	750.
" " good	$\frac{5}{8}$	15.	625.
" " common	$\frac{1}{2}$	12.	500.
Commonest solder	$\frac{1}{3}$	8.	333.3

The table gives the amount of pure gold; subtracting which from the number at the head of each column will give the amount of alloy.

For example: best jewelers' gold contains 18 carats of pure gold and 6 carats of alloy; or three-fourths pure gold and one-fourth alloy; or 750 parts pure gold and 250 parts alloy.

To know how much alloy is required to reduce gold from one fineness to another, Prof. Austen gives the following rule: *Divide the lower carat* (c) *by the difference between the lower carat* (c) *and the higher* (C); *divide the weight* (W) *of the gold by this quotient* (c ÷ (C—c)), and it will give the amount of alloy (A) to be added. He also gives the following table of DIVISORS, which will be found convenient, as saving the necessity of much calculation :—

CARATS.	22.	21.	20.	19.	18.	16.	14.	12.
24.	11.	.7	.5	3.8	3.	2.	1.4	1.
22.		21.	10	6.3	4.5	2 6	1.7	1.2
21.6		35.	12.5	7 3	5.	2.8	1.8	1 3
20.				19.	9.	4.	2.3	1 5
18.						8.	3.5	2.

The first vertical column represents the fineness *before* alloying: first horizontal column the fineness *after* alloying. Example: To reduce a double eagle (weighing 516 grains, 21.6 carats fine) to 20, 18, and 12-carat plate, divide the weight by 12½, 5, and 1⅓; this gives the amounts of alloy to be added—for the first, 41.3 grains; for the second, 103.2 grains; and for the third, 387 grains.

When it is required to know the fineness of the plate or solder made from known quantities of gold and alloy, *multiply the weight* (W) *of gold, before alloying, by its carat valuation* (C); *divide this product* (CW) *by the weight of the gold after alloying* (W + A); the quotient will be the carat value (c) of the alloyed gold.

This and the preceding rules may be also expressed by algebraic formulæ:—

$$(1) \qquad A = W \div \frac{c}{C - c}. \qquad\qquad (2) \qquad c = \frac{CW}{W + A}.$$

The fineness of any mixture of alloys of known value may be found by a simple arithmetical rule. Multiply each weight by its carat (pure gold being 24), divide the sum of the products by the sum of the weights, and the quotient will be the carat value of the mass.

The following formulas may be employed for manufacturing gold plate from pure gold for dental purposes: Nos. 1, 2, and 3 for the base, and No. 4 for clasps :—

No. 1.

Gold Plate 18 *Carats Fine.*

18 dwts.,	pure gold,
4 dwts.,	pure copper,
2 dwts.,	pure silver.

No. 2.

Gold Plate 20 *Carats Fine.*

20 dwts.,	pure gold,
2 dwts.,	pure copper,
2 dwts.,	pure silver.

No. 3.

Gold Plate 21 *Carats Fine.*

21 dwts.,	pure gold,
2 dwts.,	pure copper,
1 dwt.,	pure silver.

No. 4.

Gold Plate 20 *Carats Fine.*

20 dwts.,	pure gold,
2 dwts.,	pure copper,
1 dwt.,	pure silver,
1 dwt.,	platinum.

The following formulas may be employed for manufacturing gold plate from coin gold: No. 1 for the base and No. 2 for clasps:—

No. 1.

Gold Plate 18 *Carats Fine.*

20 dwts.,	coin gold,
2 dwts,	pure copper,
2 dwts.,	pure silver.

No. 2.

Gold Plate 20 *Carats Fine.*

20 dwts.,	coin gold,
8 grs.,	pure copper,
10 grs.,	pure silver,
20 grs.,	platinum.

Gold plate 20 carats fine according to formulas No. 4 and No. 2 is suitable for clasps, backings, and irregular appliances where great strength and elasticity are required.

The following formula of Johnson Bros. gives an 18-carat gold plate:—

United States gold coin,	64½ dwt ($60)
Pure silver,	18 dwt.

CHAPTER VII.

INGOT MOULDS, ROLLING MILLS, SOLDER.

The gold, after being refined or alloyed, should be re-melted in a clean crucible, well rubbed on the inside with borax, and poured into an ingot-mould (Figs. 792, 793) of proper length, width, and thickness.

Ingot-moulds may be of iron, soapstone, asbestos, charcoal, or carbon. The first is perhaps most convenient. The second gives, with the same gold, a tougher ingot; the asbestos ingot block, which may also be used for melting, is a perfect non-conductor, and is

represented by Fig. 794; it is 2½ inches wide and ⅜ inch thick. With the charcoal ingot mould the greatest toughness of metal is obtained, so far as the nature of the ingot-mould can modify it. Pig-iron, from the same furnace, run into iron moulds, may be white and brittle; or into sand moulds, gray and less brittle; or into charcoal, dark gray and soft. Some such modification of the molecular arrangement of gold, due to its manner of cooling, is probably the correct

FIG. 792.

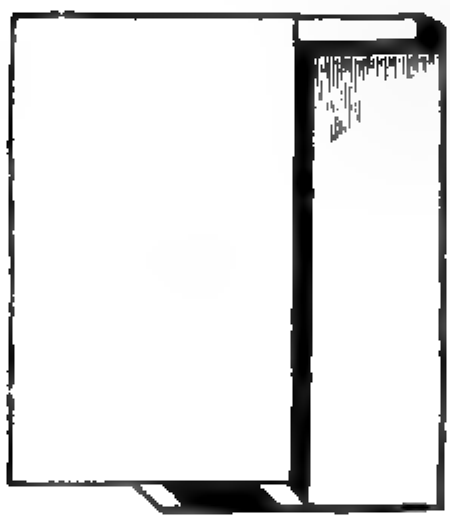


FIG. 793.

explanation of the fact that a charcoal mould yields, other things being equal, a tougher ingot than iron.

An apparatus is now in use which combines the crucible and ingot-mould, in which a crucible, or moulded carbon, communicates

FIG. 794.

with an ingot-mould, both held in position by a clamp underneath, and swiveling on a cast-iron stand. The metal to be melted is placed in the crucible, and the flame of a blowpipe is directed on it until it is perfectly fused. The waste heat serves to make the ingot-mould hot, and the whole is tilted over by means of an upright handle at the back of the mould. A sound ingot may be obtained at any time in about two minutes.

The charcoal ingot mould is easily made. Select a fine-grained

piece; saw in half and make smooth by rubbing the surfaces together. Then make the matrix in one of three ways: either cut the shape required out of one-half, with the proper gate; or bend a heavy wire into shape of the ingot and gate, and bind it between the surfaces; or saw off a charcoal slab, and after cutting out the shape of the ingot and gate, bind it between the surfaces. Those who have once used a charcoal ingot will seldom use any other.

After it has become sufficiently cool, it may be placed on an anvil, and its thickness reduced to about an eighth of an inch, with a hammer weighing from one to one and a half pounds. It should then be well annealed by being placed in the furnace, lightly covered with small pieces of charcoal, and heated until it assumes a uniform cherry-red color; or it may be annealed with a blowpipe. It may be necessary, during the operation of hammering, to subject it once or twice to this process to prevent the gold from cracking. If, notwithstanding this precaution, it should crack, it must be again melted, and refined with muriate of ammonia. Sudden cooling does not make it brittle. On the contrary, some jewelers maintain that if plunged in alcohol and water it is softer than when slowly cooled. A little sulphuric acid in the water will give a bright surface to the plate by cleansing off the oxide of copper; but this acid pickle is only necessary for removal of the metal of the dies used in swaging, or of the borax used in soldering; in all other cases we prefer to have the oxide coating.

After the gold has been reduced to the thickness just mentioned and well annealed, it may be placed between the rolls of the mill, previously so adjusted as to be the same distance apart at both ends, and not so near to each other as to require a great effort to force it between them. The rollers, however, should be brought a little nearer to each other every time the plate is passed between them; and during this process they should be kept well oiled, so that there may be as little friction as possible. Many roll the ingot without any previous hammering. In the process of rolling care must be had to anneal often, and to roll in one direction until sufficient width of plate is obtained; then, before cross-rolling, be sure to anneal, else the plate will be very apt to crack.

Rolling mills for gold are variously constructed. Some are very simple, while others are quite complex, have a great deal of machinery connected with them. The rollers also vary in length from three to five inches. For the gold plate used by dentists, they need not be more than three or three and a half inches long. Fig. 795 represents a simple form of rolling mill, without the cog-gearing, as seen in Fig. 769. The latter is a strong but simple mill, and

is very well suited to the dental laboratory. The set-screws at the top are turned with a rod, and must be both moved alike, else the plate will be thicker on one side, and will curve laterally in rolling.

Fig. 797 represents a more complicated mill, designed for those who do much or heavy rolling. With such a mill, all the heavy rolling of a laboratory could be done without the aid of an assistant.

The thickness of the plate may be determined by a gauge plate. That which is to serve as a basis for artificial teeth for the upper jaw may be reduced until it fits the gauge at 25, 26, or 27, according to the quality of the plate and the depth or irregularity of the arch. For the lower jaw, and for backings and clasps, it may range from 21 to 24. When the whole alveolar border and a portion of the roof of the mouth is to be covered, it may be a little thinner

FIG. 795.

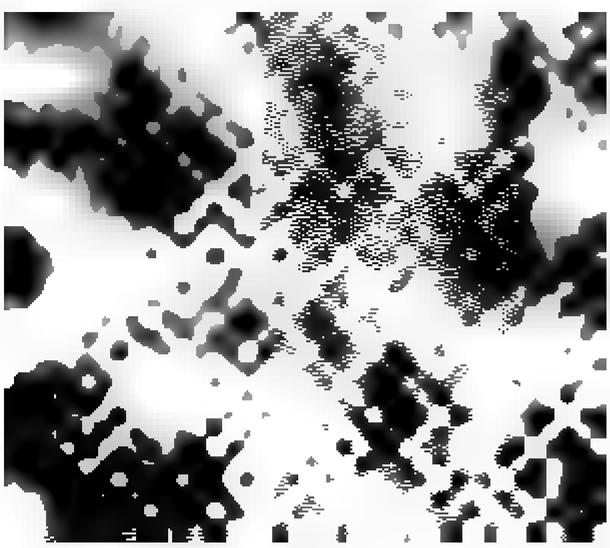


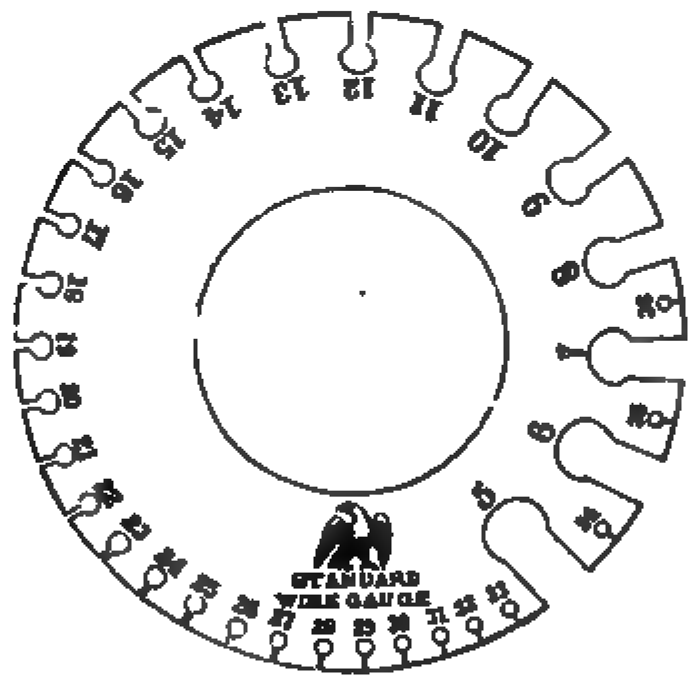
FIG 796.

than when applied only to a small surface; also thinner when the arch is deep or irregular. The purer the gold is, the thicker must be the plate. When very wide clasps, too, are employed, it is not necessary that the gold should be as thick as if required for narrow ones; and low or wide backings need not be so thick as long or narrow ones. Lower plates, if wired around the edge or doubled over the middle third, may be made of the same thickness as an upper plate. But these are matters which the judgment of the dentist alone can properly determine, and, consequently, no rules can be laid down upon this subject from which it will not sometimes be necessary to deviate.

Gauge plates are, unfortunately, not uniform. For many years the most reliable were those manufactured by Stubbs. But it is difficult to procure them. At the same time it is very important that some standard should be adopted in the profession. Under these circumstances we approve the suggestion of the late Dr. S. S. White, who recommended the gauge plate given in Fig. 798, which

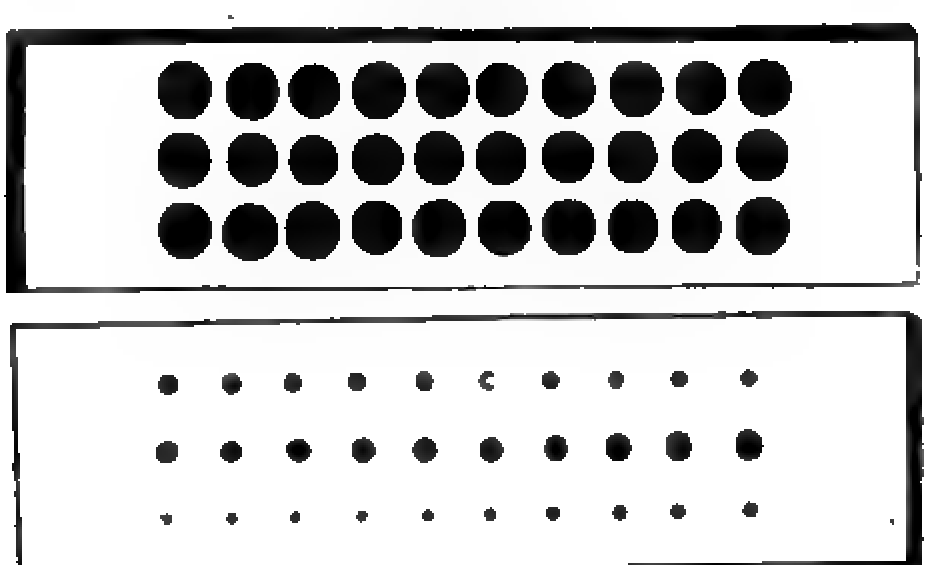
has been adopted by the principal brass manufacturers of this country.

FIG. 797. FIG. 798.



It may be necessary sometimes to make gold wire for spiral springs or other purposes, also hollow-tube wire. A draw plate

FIG. 799.



(Fig. 799), strong pliers, and bench vise (Fig. 800) are the necessary tools for this purpose. The draw plate should be of the hardest

steel, with the holes diminishing very gradually. The pliers should be rough at the end, for grasping the wire, which must be often annealed during the process.

Tube wire may be obtained from the jewelers, by whom it is known as joint wire. But it is seldom over sixteen carats fine. For use in the mouth it should be not less than twenty carats; but for many purposes pure gold or platinum tubing is better. It is easily made as follows: Take a small strip of plate one-fourth of an inch wide, one or two inches long; slightly taper one end; bend it around a mandrel or common knitting needle, and pass it into one of the larger holes of the draw plate. Then with the pliers draw it through and repeat until the edges of the strip meet. Remove the mandrel and solder the seam with fine gold or else pure gold. Lastly, select a mandrel or needle, the size of the required tube, and draw the

Fig. 800.

wire until it has the proper thickness. If the bore is to be smaller than any needle at hand, the last drawing may be done without the mandrel.

The simplest method of winding wire into a spiral spring is to secure it between two blocks of wood, held between the jaws of a small bench vise, as shown in Fig. 800. The upper end of the wire is then grasped by a hand vise or sliding tongs, in connection with a spindle or steel wire the size of a small knitting needle, six or eight inches in length. The spindle, resting on the blocks of wood, is made to revolve, and by this movement the gold wire is drawn through the blocks and wound firmly and closely round the steel rod.

GOLD SOLDER.

In making gold solder, the materials employed for the purpose, if not pure, should be refined separately. Unless this is done, it will be difficult, and often impossible, to ascertain their relative purity, which should be known to insure the desired result. The gold is placed in a clean crucible with a little borax, and as soon as it has become perfectly melted the silver, and afterward the copper, are added. When all are melted, the alloy may be immediately poured into an ingot-mould, previously warmed and oiled. The process of hammering and rolling the solder is the same as that described for gold plate. In consequence of the large amount of alloy in solder, it is sometimes so stiff, and even brittle, as to be with great difficulty rolled; this difficulty is increased by the fact that its low fusibility makes it not very easy to anneal without melting. This is especially the case with solders in which zinc or brass is used.

In making solder into the composition of which zinc enters, the other ingredients must be thoroughly melted, then the zinc (or brass) introduced at the last moment, rapidly stirred, and the metal quickly poured. A piece of charcoal will be found better for making small quantities of solder than a crucible.

The solder employed for uniting the various parts of a piece of dental mechanism should be sufficiently fine to prevent it from being easily acted on by the secretions of the mouth.

If pure gold is used, the solder will be of finer quality than if twenty-two-carat gold is used, but will not flow quite so readily. But twenty-two-carat plate may be used, if its alloy is known, by making due allowance for the amount, which is easily calculated by use of preceding rules. The following makes a solder sixteen carats fine, and may be used for eighteen- or twenty-carat gold plate; it flows very freely :—

No. 1.—Pure gold,	. . . .	6 dwts.
Fine silver,	. . . .	1 "
Roset copper,	. . . .	2 "

By adding one or two grains of zinc, a solder may be made that will flow at a lower temperature than that made by recipe No. 1. It will also have a finer gold color; but it is apt to impart to the piece a brassy taste, and for this reason the author rarely uses it. Zinc solders are apt not only to have a brassy taste, but also to become brittle after long use.

The following formulas will give solder fourteen carats fine; the first from Johnson Bros. :—

No. 1.		No. 2.	
Pure silver,	2½ dwts.	American gold coin,	$10
" copper,	20 grs.	Pure silver,	4 dwts.
" zinc,	85 "	" copper,	2 "

The following formulas from the *American System of Dentistry* are suitable for bridge- and crown-work, and are twenty carats fine:—

No. 1.

American gold coin (21.6 carats fine) ($10 piece),	258 grs.
Spelter solder (composed of equal parts of copper and zinc)	20.64 "

No. 2.

Pure gold,	5 dwts.
" copper,	6 grs.
" silver,	12 "
Spelter solder,	6 "

Dr. D. H. Goodno's formula, which is said to give a gold solder which is remarkably tough, flows readily, and does not discolor in the mouth, is composed of the following alloy:—

Pure gold,	40 grs.
" silver,	2½ "
" copper,	2½ "
" zinc,	2 "

In the melting process the zinc is rolled in gold foil and placed in the crucible and covered with borax. The copper and silver are then added and also covered with borax, and the whole melted. To use this alloy for a twenty-carat plate, 5 dwts. of pure gold are added to 1 dwt. of the alloy; for eighteen-carat plate, 5½ dwts. of pure gold to 1½ dwts. of the alloy.

The following formulas, taken from Dr. Richardson's work on "Mechanical Dentistry," furnish solders (No. 4) over fifteen carats fine, and (No. 5) eighteen carats fine:—

No. 4.		No. 5.	
Gold coin,	6 dwts.	Gold coin,	30 parts.
Silver,	30 grs.	Silver,	4 "
Copper,	20 "	Copper,	1 "
Brass,	10 "	Brass,	1 "

Other recipes might be added, but the foregoing have been found with us to answer every purpose. More difficulty arises in the use of solders from a wrong method of soldering than from defect in the solders themselves. Almost every dentist will be found to have his

favorite recipe, which "invariably flows smoothly." The very fact that so many hundred different solders work so well goes far to prove what we have said. Some will boast of using a solder as fine as the plate. This may be true if by "fineness" we mean simply carat valuation. But a solder containing two grains of zinc to the dwt. is in no true sense as fine as a plate alloyed with that amount of copper; yet both are twenty-two-carat metal. Rules for the management of solder, plate, and blowpipe, in the act of soldering, will be hereafter given.

CHAPTER VIII.

CUPS AND MATERIALS FOR IMPRESSIONS OF THE MOUTH—PLASTER MODELS.

IN the construction of a dental substitute, mounted upon a plate or base, it is necessary to obtain an exact model of the parts upon which it is to rest and to which it is to be attached. For this purpose a perfect impression of these parts must be obtained, involving—first, the choice of a suitable impression cup; secondly, the selection of an impression material.

IMPRESSION CUPS OR TRAYS

must be of such size and shape as to permit their easy introduction into the mouth; also must they follow, as nearly as possible, the

FIG. 801.

FIG. 802.

outline of the surfaces to be copied, allowing a uniform space of one-fourth or one-eighth of an inch for the material. These cups

are sometimes called mouth cups; but we think the name given, and now generally used, is greatly to be preferred. They are of two kinds, metallic and gutta-percha.

Metallic cups were formerly made of sheet tin, cut into shape and soldered, and were so imperfect that it was very often necessary

Fig. 803.

Fig. 806.

Fig. 805.

to swage metallic cups to suit special cases. The depots now supply an excellent assortment of well-shaped Britannia impression cups, of which sixteen will constitute a full set; namely, six sizes

for full upper cases, and three for full lower; three sizes for partial upper cases (in these the outer rim rises at a right angle), and four for partial lower (these cups have a depression or a place cut out to receive the front teeth).

Figs. 801 and 802 illustrate full upper and lower impression trays.

Figs. 803 and 804 illustrate partial upper and lower impression trays with flat bottom and square sides.

Figs. 805 and 806 illustrate adjustable impression trays. In taking impressions of deep, narrow mouths, or where a masticating tooth standing alone widens the jaw at a particular point, it is sometimes desirable to be able to readily adjust the size and shape of the tray used. Upper, Fig. 805, and lower, Fig. 806, impression trays have been designed to meet this want. Either of these can be made into a partial tray by cutting off one side.

Fig. 307 illustrates Southwick's upper impression tray with raised palatine edges to prevent the plaster from slipping off.

Fig 807. Fig. 808.

Fig. 808 illustrates a partial lower tray with an opening to allow the front teeth to pass through and the tray to pass down to the maxillary ridge. A piece of wet paper is placed over the opening when the cup is filled with the plaster-batter.

Fig. 809 illustrates Dorr's lower impression tray with posterior lingual wings, which enable the operator to obtain an accurate impression of the jaw on either side of the tongue. These wings may easily be spread apart, or brought toward each other, or twisted, or cut away to adapt the tray to nearly any size or shape of the edentulous lower jaw.

Fig. 810 represents Dr. Franklin's cup for full lower impressions; the slot and upper groove permit secondary pressure of the wax or

plaster, after the surplus material is forced up, as it is pressed on the alveolus.

"This cup, or rather double cup, has a groove or space in its centre all the way round. The advantages of this groove are, that, when the lower part of the cup is filled, and the upper part one-fourth full of plaster, and placed in position over the ridge, the operator, with the end of the finger or other suitable means, can gently agitate the whole mass of plaster in the cup, and thus prevent air-bubbles, blanks,

FIG. 809.

or other imperfections on the surface of the impressions. The peculiar shape of the outer flanges of this cup is such as to distend the cheeks, while the lower inner edges, pressing upon the submaxillary and sublingual glands, depress them sufficiently to prevent any fold or ligamentous attachments from being embraced by the impression.

Fig. 811 represents the Wardle cup, which is supplied with a movable palate plate, so adjusted that it is capable of forcing the centre of the impression material against the highest part of the arch, as well as laterally against the palatal sides of the necks of any remaining teeth.

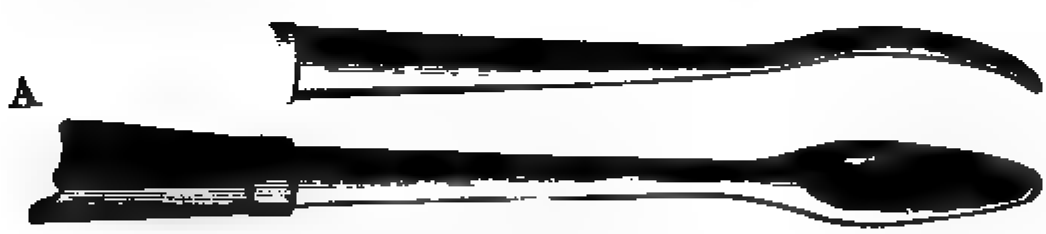
Fig. 812 represents Fouke's impression cup, by which it is claimed

a correct impression in all variety of cases, both partial and full, can be obtained. It consists of a metallic portion with a canvas lining.

Fig. 811.

The design of the cup suggests of itself the manner of using it; which consists of the ordinary pressure against the metallic part of the cup, in connection with a proper distribution of pressure with

Fig. 812.



the fingers and compressing instrument A, against the canvas lining of the cup, C C; the latter pressure must be made with a degree of firmness and steadiness sufficient to compress thoroughly all parts of the mouth.

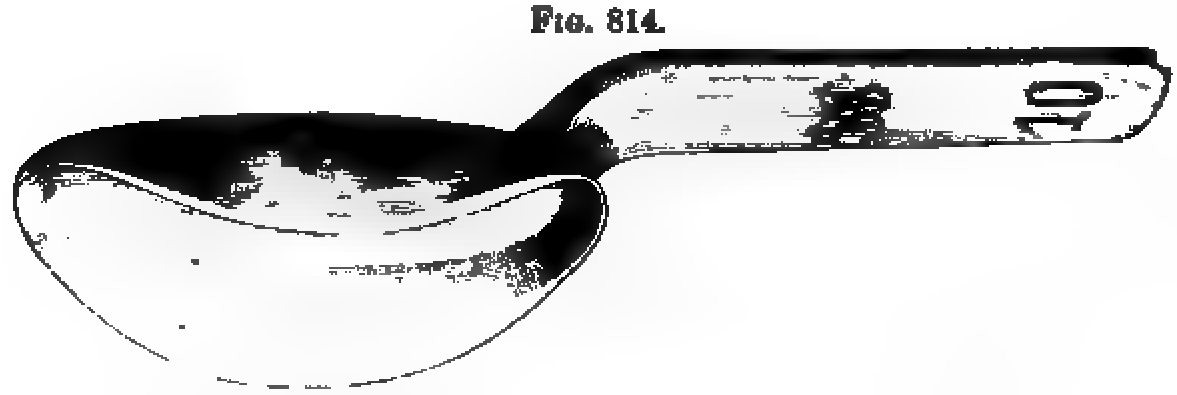
Exceptional cases, which no form of purchased cup will suit, may require a swaged brass, zinc, copper, or silver cup; or a cup cast out of Britannia metal, or other tin alloy. The process of swaging will hereafter be described; also, the method of moulding a cup from a pattern of wax. Most of these cases, however, may be met by bending, hammering, or cutting the ordinary Britannia cup; remembering always that a wise economy never hesitates to sacrifice the cup to secure excellence of the impression or the saving of time. Without this adaptation of the cup to the form of the alveolar ridge and palate it is impossible, in certain mouths, to get a good wax or gutta-percha impression. Fig. 813 illustrates a partial upper tray for one or two teeth, which is useful in pivoting and bridge-work.

Fig. 813.

Fig. 814 illustrates Mathews's partial upper or lower tray.

Cups similar in shape to the Britannia, but not in so many varieties of size, are also made of hard rubber and porcelain. The first cannot easily, and the latter cannot at all, be modified in shape to suit special cases. The porcelain cups are handsome and clean looking, but they are easily broken; and when plaster is used, it will sometimes leave the glazed surface and cling to the mouth. We, therefore, prefer the Britannia cup, unless the case requires Prof. Austen's gutta-percha cup.

Fig. 814.



These cups were originally devised to meet a difficulty incident to vulcanite partial pieces. Perfect impressions of dove-tailed inter-dental spaces, and the lingual side of molars and bicuspids, often undercut, are impossible in wax or gutta-percha. Yet Prof. A. regarded this as essential to the proper construction of a partial vulcanite set of teeth.

They are thus made: Take a wax impression and make a model; in partial cases, brush over the teeth of the model one or two layers

of thin plaster, to fill up all undercuts, and to make the plate fit loosely; saturate the model with water, and mould over it a gutta-percha cup. This last is done, not by using the gutta-percha in sheet, but by first making into a ball; then working it from the palate outward, leaving a thick mass in the centre. It should be, on the inside, from one-fourth to one-half of an inch thick, so as to be stiff and unyielding; but on the outside not more than one-eighth or one-sixteenth thick, so as to be slightly elastic and yielding. The whole inside of the cup must be roughened up with a scaler or excavator in such a way that the plaster can take firm hold. In most partial cases, the impression will have to be removed in sections; the inside remaining entire, but the outside and the parts between the teeth coming away separately. In certain cases it is necessary to partially cut through the cup before putting in the plaster, and usually upon the thick masses of gum which fill the interdental spaces. A cut on the inside, in line with the ridge, gives pliancy to an otherwise rigid cup, and permits its easy removal. When it is desirable to extend the cup around the entire arch, so as to get an exact plaster impression, not only of the gum but of all the remaining teeth, this rim of gutta-percha must be slit at two or three points, to give that pliancy which is a chief merit in this form of cup. These cups have no handle, but are removed by inserting a plugging instrument into a small hole previously made in the back part of the cup, where it is thickest.

IMPRESSION MATERIALS

Must possess the following properties: (1) Plasticity in sufficient degree to copy mucous tissues, avoiding the extremes of softness, which permits them to flow from the cup, and of hardness, which requires excessive pressure. (2) The property of hardening within a short time, and under conditions not incompatible with the mouth. (3) Absence of expansion or contraction, except in very moderate degree. It may also be added that the materials should not be such as, in taste, smell, or appearance, are calculated to disgust the patient.

There are four materials answering to these requirements, and possessing properties as distinctive as the sources whence they are derived. From the Animal kingdom, Beeswax; from the Vegetable kingdom, Gutta-Percha and Modeling Composition; from the Mineral kingdom, Plaster. After their separate description, a brief review of their distinctive properties will be given. No one of the four can be dispensed with; no one should be exclusively used.

Beeswax.—Formerly the only material used, and is yet very useful for certain cases, and is absolutely indispensable for other dental purposes. The best wax is from virgin combs, and has a rich golden color. Commercial adulterations with tallow, etc., injure it, and mixture with resin makes it harsh and difficult to manage. Gutta-percha is sometimes incorporated with it to give hardness in warm weather; bleached or white wax is also used for the same purpose.

A very valuable addition is paraffine. Pure paraffine is very plastic, softening at a low temperature (100°); but the folds of soft paraffine have no tendency to reunite, and consequently the mass is full of easily separated flakes or layers. It imparts this property to wax, if in too large proportion; but its moderate use greatly improves the wax. It causes it to soften at lower heat, makes it more plastic when warm, and harder when cool.

The depots furnish wax and its compounds in very pure, neat, and convenient forms; so that there is now little necessity for the dentist to spend the time once demanded to reduce the thick cakes into serviceable shape. It may be well, however, to state briefly how to prepare wax for impressions. Melt and pour into cakes one-quarter of an inch thick; cut into pieces about two inches square; and when nearly cold roll on a wet board, with a wet wooden roller, to one-half or one-fourth this thickness. This breaks down the crystallization, and reduces it to a form very convenient for softening when wanted for use. It may be softened over a broad flame, or before a fire or stove, or in warm water. In using dry heat be careful not to melt the surface, or give the peculiar whitish appearance that precedes melting. In using water, have a large quantity, to secure uniformity of temperature, and keep it at 120°–130° Fahrenheit. Below this it will not yield readily to the gum; above this it becomes adhesive.

Some practice is necessary in knowing the proper quantity of wax to use in the cup; the usual mistake is to take too much. Select a cup of proper shape and size; if the arch is a deep one, put some hard wax or gutta-percha in the centre to force up the wax at that point. This is much better than to have a hole in the cup through which to make pressure with the finger. Such cups are worse than useless, for it is impossible to make secondary pressure without injury to other parts of the impression, except in case of wax projecting above the cup, outside the ridge. Put the wax in the cup; smooth the surface, which should be a little softer than the body of the wax; then introduce and press against the gums or teeth with a steady, uniform, and moderately strong pressure; also, as nearly

as possible, in a direction at right angles to the plane of the alveolar ridge.

The wax above the cup is pressed against the gums on each side, so that an exact impression may be obtained of all the depressions and prominences on the outside of the arch. But this must be done with great care, holding the cup firmly and pressing the finger against the cheek or lip, rather than directly upon the wax. It is much better in all cases to have the sides of the cup high enough to give the wax support at all points. For this purpose, it becomes necessary sometimes to swage or cast a special cup. Very perfect wax impressions can be taken in such cups. On the removal of the cup and wax from the mouth, the greatest precaution is necessary to prevent injuring or altering the shape of the impression. Holding the handle firmly, it must be drawn directly downward, in case there are front teeth, in the direction of the axes of these teeth. Impressions of a full upper arch sometimes adhere very tightly. They can generally be loosened by drawing up the cheek and lip on one side or both sides alternately; or by a slight cough, which, acting upon the palate, admits air behind and above the impression. Any violence or twisting motion injures the impression; in wax or gutta-percha such defects cannot be detected until, on completion of the plate, maladjustment creates suspicion of its cause. The wax must be kept in the mouth long enough to cool and harden. A small piece of ice in a napkin, held against the under side of the cup, will rapidly harden it. This simple plan is preferable to the use of double cups, into which a stream of cold water is injected. The latter are not only expensive and troublesome to use, but they endanger the accuracy of the impression. All wax impressions, unless for models on which other cups are to be made, should be hardened by artificial cold; it greatly helps to prevent change of shape on withdrawal. If the surplus wax, by contact with the lips or teeth, injures the impression, then, if it is a full case, cut off the surplus, dip into warm water, and introduce the same impression a second time; but if it is a partial case, it must be taken anew, for the teeth cannot, with any accuracy, enter their wax impressions.

Gutta-Percha.—This very valuable material will be found useful in taking impressions of the lower jaw and in some partial cases, also frequently in full upper cases where the teeth are set on a vulcanite base. The manipulations are different, accordingly as we wish to make the gutta-percha adhere to the cup, or wish it to part from the sides of the cup as it shrinks on cooling. In the first case, soften in water heated to 180°–200° Fahrenheit; dry off the water;

hold for a few moments over a flame, and press into a warm cup; keep the fingers wet, to prevent the gutta-percha from sticking, but do not let water get between it and the cup. In the second case, keep the surface of the gum wet, and introduce it into a cold and wet cup. When the cup is filled, place again in water at 180°; then press it somewhat into shape, and introduce into the mouth. Pressure must be more gentle than for wax; it must be kept longer in the mouth, and ice should be used to cool it. Be very careful, in partial cases where there is much undercut or a dovetail space between teeth, not to make the gutta-percha too hard, else it will be almost impossible to get it out of the mouth.

Gutta-percha copies surfaces with all the accuracy of plaster; but, although harder than wax, it is more apt than plaster to change its shape upon withdrawing it from the mouth. Its characteristic peculiarity is contraction on cooling; but this is controlled, when required, by the directions above given for making it adhere to the cup. It is less easily manipulated than wax, and not so generally useful; but its property of contraction admirably adapts it to certain cases in which plates, otherwise accurate, fail, because too large and loose.

Gutta-percha for impressions is supplied in convenient form by the depots. The native color is dark, and calculated to repel fastidious patients. For this reason, also to give it body, it is incorporated with about its own weight of white oxide of zinc, magnesia, or chalk, and a pinkish color given by vermilion. Thus prepared, it is less sticky when softened, and becomes harder, when cool, than the crude article.

Modeling Composition or Compound is composed of gum dammar, stearine, French chalk, with carmine to color it, and a perfume to render it pleasant. Four varieties are manufactured—the soft, the medium, the hard, and the extra soft, differing as to the quantity of stearine and chalk incorporated with the gum. Modeling composition is an excellent material for impressions, as it copies very accurately and affords a smooth model. The best manner of using it is to soften this material in boiling water contained in a shallow vessel. When it is thoroughly softened, and not too hot to handle, the cup for its reception should be slightly warmed, into which it is introduced in the same manner as wax. After it is applied to the mouth, it is allowed to cool somewhat, after being pressed around the outside of the alveolar ridge.

The same care is necessary in removing it from the mouth as with wax, and it should be immersed in cold water at once, to harden it. Before pouring the plaster the impression should be dipped in cold

water. To remove an impression of this material from the plaster model, both are immersed in boiling water, where they should remain until the compound becomes soft, but not adhesive, when it is easily separated from the model.

Plaster—Gypsum, Sulphate of Lime, or *Plaster-of-Paris*—consists of 28 parts lime, 40 of sulphuric acid, and 18 of water; the first its mineralogical name, the second its chemical, the third its commercial. A beautiful translucent variety of gypsum is known as *alabaster;* the transparent crystalline variety is called *selenite*. That, however, used in agriculture and for calcining is in amorphous masses of a grayish or bluish-white color. When exposed to a heat between 300° and 400° Fahrenheit, most of the water of the gypsum escapes. It is then known as calcined plaster, plaster-of-Paris, or simply plaster. After being properly calcined and pulverized, if mixed with water to the consistence of thin batter or cream, it hardens in a few minutes, and acquires great solidity. The plaster has chemically reunited with a portion of the water, while another portion is mechanically held in the porous mass, and may be driven off by drying. During the process of consolidation it expands, in consequence of the absorption of the water by the particles of plaster. If the plaster is very fine-grained, this absorption takes place quickly, and the expansion occurs while the plaster is soft. But coarse-grained plaster sets before the particles become thoroughly saturated; hence it continues to expand, more or less, for some time after solidification. There is a great difference in the quality of plaster. That used for taking impressions of the mouth (and, in fact, for all dental purposes) should be of the best description, well calcined, finely pulverized, and passed through a sieve of bolting cloth previously to being used. The idea of taking impressions for full sets of teeth with plaster originated, we believe, almost simultaneously with Drs. Westcott, Dunning, and Bridges, by whom and the profession generally it has been regarded as adapted almost exclusively to full impressions. Prof. Austen introduced a method of using it in connection with gutta-percha cups, which makes it, in the hands of a careful manipulator, universally applicable to every case in which a dental appliance is called for. He would, however, by no means recommend such universal application, claiming only that the gutta-percha cup will give with plaster a correct impression of partial cases of greatest irregularity, where the use of wax or gutta-percha would be impossible.

For plaster impressions in ordinary full cases, upper and lower, select a Britannia cup, about one-eighth of an inch larger than the alveolar ridge, and, in case of a deep upper arch, build up with wax.

so as to give support to the soft plaster; also supply with wax any deficiency in the size of the cup at the back part or around the outside edge. In exceptional cases requiring a special cup, a gutta-percha one will be found to be much easier made than a swaged or cast metallic cup. If properly shaped, it will fully answer the purpose.

The late Dr. Bean's practice was to take a wax impression, make model and dies, and swage a plate; then solder a strip from ridge to ridge, to hold a stick, which was to act as a handle in removing the impression. He then heated the plate, and coated the palatine surface with shellac, pressing a lump of raw cotton against the adhesive resin. The cotton fibres caused the plaster to adhere firmly to the plate, thus avoiding the great annoyance when scales of plaster, so thin as in this kind of cup, break off. The process is troublesome, but the results are very satisfactory.

To take a plaster impression, place a patient in a common chair, and after the cup is introduced, incline the head forward, holding it in place with a gentle but steady pressure upon the centre of the cup. The plaster should be very fine-grained and mixed rather thin, to get rid of air bubbles. If necessary, a little salt or a few grains of sulphate of potash should be added, to quicken slow-setting plaster. The necessity for salt and quantity to be used should not be left to conjecture; hence the importance of setting aside in a well-closed vessel a quantity of "impression plaster." Also, if the plaster is "slow," set aside a large bottle of salt water of the exact strength required to make that plaster set properly. There will, in this way, be no danger of the plaster setting too quickly or too slowly. If made to set too rapidly, it hurries the operator and increases the risk of failure; if it sets too slowly, both patient and operator become wearied before it is hard enough to remove. Tepid water promotes the setting of plaster. It should require about three minutes to harden after it is introduced into the mouth, which must be done when it is stiff enough to allow the plaster to be moulded into some shape, and yet soft enough to permit no sharp points or angles on its surface. If softer than this, the slightest pressure forces it out of the cup to run sometimes out of the mouth, sometimes on the tongue and fauces. This also is apt to occur if an excess of plaster is used. These unnecessary accidents are well calculated to prejudice patients against plaster, and, perhaps, against the operator.

The hardness of plaster in the mouth can be ascertained by the watch, when the exact time required for setting is known, or by testing some of the plaster remaining in the bowl. As soon as it breaks with a sharp fracture, it should be removed. To keep it in

much longer than this is apt to give unnecessary pain and difficulty in removal, owing to the absorbing property of the hardened plaster, which causes it to cling with great tenacity to the mucous membrane.

Full lower impressions are generally easy to withdraw; but some full upper ones adhere very tenaciously. Raising the cheek on one side or in front, and depressing the cup, will detach most cases. This can be done, in case of plaster, without risk of injuring the shape of the impression. If this does not loosen it the patient may be requested to give a slight cough. Where there is much undercut, the plaster will break; but it can readily be replaced. Sometimes the action of the cheeks and lips, or of the soft palate, will loosen the impression; or an instrument may be used to press up the palate, and thus cause air to pass in at the back, when it may be easily removed. Complicated modifications of the cup to facilitate removal are of little value, and make an unnecessary multiplicity of apparatus.

In partial cases, the outer rim (which for this purpose is made elastic, or else in sections) is first detached, and the central portion then loosened by an instrument inserted into the *back* part of the gutta-percha cup. If there should be many broken, detached fragments, either loose or caught in dovetail spaces between the teeth, these must be very carefully removed; and when the surface moisture has dried off, they must, with the utmost nicety, be replaced in the impression. This is sometimes a tedious and difficult operation; but it is not trouble misapplied, since it is the *only* way in which perfect impressions of difficult partial cases can be obtained. Should the detached plaster be from a very irregular surface, its readjustment is made much easier by touching the gutta-percha at that point with a camel's-hair brush dipped in very hot water. The fragments being all adjusted and the outside ones secured by a little resinous cement, should there be much broken surface on the inside, it is best to varnish heavily with sandarach to cement the pieces; otherwise, let the surface be prepared, as in full sets, for preventing the plaster of the model from adhering.

Wax and gutta-percha require nothing for this purpose, or, at most, a very thin layer of oil. Plaster impressions may be rendered separable: 1, by an alcoholic varnish of sandarach or shellac, or a diluted solution of soluble glass, with a little oil upon the varnished surface when dry; 2, by saturating it with as much oil as it will take up without standing upon its surface; 3, by coating the surface with a dilute soap mixture. The varnish may be either transparent or colored; the transparent varnish consists of gum sandarach, ℥v, alcohol, Oij; the colored varnish consists of the same propor-

tions of gum shellac and alcohol. The gum is added to the alcohol and digested over a moderate heat until it is dissolved. The varnish is best applied with a small bristle brush; the oil and soap water with a camel's-hair brush or a stiff, pointed feather. The varnish must be kept well stopped, or from time to time diluted, so as not to become thick. The soap mixture needs, occasionally, renewal, as the plaster gradually neutralizes its oil and renders it unfit for use.

Some dentists take plaster impressions, in certain cases, thus: First, a wax impression, as usual; then enlarge, by pressure, or by cutting out the depressions formed by teeth or a prominent alveolar ridge; lastly, they pour in a thin layer of plaster, and repeat the impression. Others surround certain teeth with a collar of wax, preparatory to taking a plaster impression.

The last is a troublesome method, very apt to fail, from the slipping of the wax collars; nor has it any superiority over a wax impression, to compensate the trouble. Dr. C. J. Essig suggest the following method for securing a plastic impression for partial cases: "An impression should first be selected of the proper size and shape; those with the flat floor are best for partial cases; the plaster should be mixed thin, almost as thin as water, adding chloride of soda to facilitate setting. Plaster mixed in this manner does not become hard and unyielding as that mixed merely to saturation. Now oil the cup so that it will readily separate from the impression when hard, fill the cup as soon as the plaster thickens sufficiently, then, with a small spatula, place a layer of the soft plaster in upon the palatine surface; otherwise by enclosing the air in the deep portion of the arch the accuracy of the impression may be impaired. After this precaution the cup is placed in the mouth, and gently pressed up until its floor comes in contact with the teeth. When the plaster is sufficiently hardened, remove the cup, which, from its having been oiled, is done without difficulty; with the thumb and index finger break off the outside walls; the portion covering the palatine surface is then removed by the use of a blunt steel spatula, curved at the end in the form of a hook. The pieces are then placed back into the cup, where they will be found to articulate with perfect accuracy. Should the first attempt be rendered futile, by the tendency to nausea or troublesome gagging on the part of the patient, camphor water, as recommended by Dr. Louis Jack, may be used as a gargle, which will, in nearly every case, prove an effectual remedy.

The comparative value of the four impression materials—wax, gutta-percha, modeling composition, plaster—can only be determined by a careful study of (1) their distinctive peculiarities; (2)

the special requirements of different mouths; (3) the kind of base-plate and manner of its construction. The exclusive use of one is as reprehensible as the indiscriminate use of all. No one is best, nor can any be dispensed with. Disregard of this most important fact is a fruitful source of failure in impressions; failures arising neither from defect in the material nor lack of skillful manipulation in the operator, but from want of philosophical selection of resources.

(1) *Wax* demands strong pressure and is inelastic; also, it neither expands nor contracts on cooling. It copies a hard gum accurately, although it never gives the fine tracery of gutta-percha, modeling composition, or plaster. It also copies a soft gum, but not until the gum is either compressed or thrown out of shape by the strong pressure required. *Gutta-percha* requires moderate pressure; is slightly elastic; also has, as its marked peculiarity, very decided contraction on cooling, which, however, is under control, as previously explained. Slight undercuts it will take, without dragging, as wax does; but, on the other hand, it will occasionally pass into very narrow interdental spaces and injure the impression in the effort to withdraw therefrom. *Modeling Composition* ranks next to plaster as an impression material, and when thoroughly softened in boiling water, and when not too hot to handle, will give an accurate impression under strong pressure and a much finer tracery than wax. *Plaster* permits only gentle pressure, taking impressions of softest tissues in natural position. It slightly expands in setting; but, in a rigid cup, this makes no appreciable increase in the size of the model. It sets so hard that it will break before leaving the smallest undercut; but, by virtue of the same quality, it can be used in the most marked cases of dovetail, or alveolar undercut.

(2) Alveolar and palatine surfaces, and their investing membranes, have a great variety of conditions. These must be carefully examined with reference to the properties, just named, of the impression materials. We have large or small arches; deep or flat ones; irregular or smooth ridges. The mucous surfaces may be uniformly hard or soft; the ridge hard and palate soft; or the more difficult combination of soft ridge and hard palate; or the ridge may be irregularly hard and soft. No one material can possibly be equal to these varying conditions.

(3) The mode of constructing the plate will often determine the choice of an impression material. A plate swaged upon a zinc die is smaller by the shrinkage of the die. Here—apart from shape or hardness of the parts—plaster would be best, wax next, gutta-percha the worst. A vulcanite plate is larger than the mouth, by the expansion of the model. Here, the contraction of gutta-percha will

often prove a very valuable compensation; also the compression of tissue, made by the pressure of wax; special considerations must determine which of these to choose. Plaster is the most reliable impression material as a general rule, and is the only material in difficult cases worthy of any reliance. It may safely be asserted that the operator who cannot take an accurate plaster impression of any partial case, however difficult, has a very imperfect idea of the value of hard rubber. For the majority of partial cases, where swaged work is used, modeling composition, or wax, if properly manipulated, will give ample accuracy. Where, however, the undercut, and consequent dragging of wax, is very great, plaster must be employed.

Large, or hard, or irregular mouths are best copied in plaster, great deviations from normal size or shape requiring special cups. A gum of medium softness, but uniform, may be taken equally well in any material. This class of mouths have a wonderful adaptation to anything. Variations in size or form must determine the selection of the material. A gum of extreme softness, yet uniform, will give better results sometimes with one material, sometimes with another. It is often very difficult to determine beforehand; but, in case of failure, let the second impression be taken always with a different material. This is especially true of lower sets, where the gum behind is soft and flexible; it is hard to say whether the pressure of wax, or modeling composition, or the softness of plaster leaves the ridge in best condition; gutta-percha is often very useful in these cases.

Irregularity of texture in the mucous tissues is a fruitful source of trouble. A hard ridge, with a soft palatine surface, is easily fitted, and any impression material may be used. But the reverse condition will often require the firm pressure of wax or modeling composition upon the ridge; also in all cases of inequality of texture in the ridge itself. As a rule, subject to exceptions, a harder impression material than plaster is the best for these mouths, and occasionally (especially for vulcanite) the contraction of gutta-percha is useful. The old-fashioned upper plates, the shape of which is shown by Fig. 815, were employed to overcome this difficulty when the central palate is very hard. Much better methods are now employed;

FIG. 815.

that of scraping the model for a vulcanite plate, and building on a thin film of wax for a metal plate. For vulcanite plates, the model is scraped slightly on either side of the hard palatal centre.

For metal plates, a thin film of wax, about $\frac{1}{16}$ of an inch in thickness, is built along the entire hard palate, terminating in thin edges, the space to be thus covered varying according to the width of the mouth. The model should also be slightly scraped at the posterior edge of the surface to be thus covered by the plate on each side of the hard portion of the palate, so that the plate may be closely adapted at such points.

It is evident that an enumeration of all the complications which call for exercise of judgment in the selection of impression materials is impossible. By suggesting a few varieties, we hope to direct attention to a much neglected point, in our judgment of utmost importance. Routine practice, which inquires into the reason of nothing, and the one-idea system, with its "practice makes perfect" motto, are equally at fault. The future may reveal some new material; but the four we now have are alike important and indispensable.

PLASTER MODELS.

The model is made of calcined plaster, mixed with water so as to have the consistence of cream, too much water making the model fragile, whilst too little will prevent the escape of the air contained in the plaster, and the model will be porous. This last condition also greatly endangers the full flowing of the plaster into the inequalities of the impression.

The model, for convenience of description, is said to have a face, back, body, and sides—terms scarcely requiring explanation. The face, corresponding with the mouth to be fitted, requires greatest care; and the same directions answer for it in all models. The body of the model has different shape and size according to the use to be made of it. The back should be, in all cases, parallel with the face. The sides are to be either vertical or slanting, according to its uses.

In making models, we require a plaster table, with a rim to prevent scattering of waste plaster, having at least two drawers in front, a shelf at the back, also an opening for escape of waste plaster into a refuse box; a tight plaster-can and a bucket of water will complete the outfit of the table. The implements are two or three strong bowls, a plaster scoop, a spatula, an iron spoon, a plaster knife, a scraper, a sponge, and some camel's-hair brushes or wing-feathers of poultry. Sometimes a marble slab or slate is used for

shaping the back of the model upon; but if the table is kept clean and smooth with the scraper, this is not essential; since, in any case, a piece of wet paper should be laid down to permit the ready removal of the model, for the purpose of shaping, whilst yet rather soft.

The most troublesome models are the thick ones for sand moulding. The surface of the impression being prepared as above directed, the cup is surrounded with a rim of wax, waxed cloth, sheet lead, or tin foil, fitting closely, to prevent escape of plaster, and about two inches deep. The rims should be slightly curved, to give, when placed around the cup, the requisite flare. Models made in such rims need trimming with the knife. To avoid this, and also to

FIG. 816.

give greatest possible smoothness and regularity to the sides, flaring rings of sheet tin may be used as follows: Set the impression level on the table, and surround with some soft, plastic material, such as potter's clay (wet newspaper made into a pulpy mass is perhaps the most convenient), and into this set a ring of such size as will give a proper shoulder to the model. Fig. 816 shows such a ring arranged for making such a model for plastic work, such as vulcanizable rubber, the models for which need not be very deep. For a sand model the ring should flare, should conform more to the shape of the cup, and be smaller. For the dipping process of making counter-dies and dies, the model needs no specially nice trim-

ming. For the fusible-metal process, the model should be cylindrical, and not flaring. These are the three forms of thick or deep model.

The shallow models are usually made without rims. The impression is filled, then turned down, when the plaster has set sufficiently to permit it, on the remaining plaster, which has been poured on a strip of wet paper placed on a smooth, flat surface. Whilst plastic it is shaped with the spatula. If for vulcanite or other plastic work, it may be taken up while soft enough to dress with a sponge. But if the shallow model is to be used in sand moulding or in Dr. Gunning's process, it is allowed to harden and is then trimmed with the knife. In vulcanite models it will save time and insure greater accuracy in articulation to extend the model at once and make the articulating portion, if no metallic articulating frame is to be employed, as will be fully explained when describing the process of articulation. The sides of vulcanite models need no shaping except such as neatness and convenience in handling require, since they are subsequently set into the flask; but they should be no larger or thicker than strength requires.

When rims are used, the impression should rest upon the plaster table; if set level, the back will necessarily be parallel with the face, since the thin plaster poured into the rim finds its level. In making shallow models the impression is held in the hand, thus permitting the flow of the plaster to be aided by moving or tapping it. As before stated, wax or gutta-percha needs no oiling; plaster may be oiled or soaped, or else varnished and oiled; it must also be saturated with water just before pouring the model.

Calcined plaster for models should not set too rapidly, as this will cause haste, with its attendant dangers. Coarse plaster makes a stronger model, but it has greater expansion. Gum-water, or size, retards the setting, but makes the model very hard; salt quickens the setting, but should not be used for any models which are to be kept as permanent records of the case. It is better to add the plaster to the water than the reverse: it makes smoother work by permitting the escape of the air; it also, by the amount of unsaturated plaster, permits the operator to gauge the stiffness of the batter.

In all cases the face of the model is the part first made. The thin freshly-mixed plaster is first to be carefully run into the depressions of the teeth or their ridges. A brush or feather is necessary when the cup is stationary; when in the hand, motion or tapping or jarring will cause the plaster to flow as desired. Perhaps the surest way to prevent defects on the face, from confined air, is to have a little surplus water in the cup. The plaster (which in this case must not be

too thin) settles at once into the smallest crevice under the water, and, if not stirred, it will not be made thin and rotten by it; or the plaster-batter may force the water before it until the latter escapes at the heel of the impression.

The impression once filled, the formation of the body is easy. For deep models, the remaining plaster should be poured at once, that, while thin, it may form a smooth and level back. For shallow models the plaster must slightly stiffen, lest the weight of the impression should make it settle too much into the plaster on the table. The

FIG. 817.

FIG. 818.

sponge is very useful in dressing up a model; it cuts more or less according to the state of the plaster. It may be used to trim vulcanite models directly after the spatula, or to give finish to other models after the use of the knife. But when plaster is fully hardened it has no effect.

Figs. 817 and 818 represent upper and lower models suitable for sand moulding; the same may be used for dipping. Fig. 819 represents a shallow model in the moulding flask, showing how the body of the die is formed by the zinc half of the flask. The same figure may be taken to represent the position of the thin model at the bottom of an iron cup, in the process of making the counter-die by Dr. Gunning's method.

FIG. 819.

Difficulties arising from undercuts, on the outside of the upper ridge and on the inside of the lower, may be overcome: (1) by filling up the undercut with wax or plaster in all places where it is unnecessary or impracticable to carry the metallic plate; (2) by using a peculiarly-constructed flask for moulding, such as the one invented by Dr. G. E. Hawes (Figs. 825–827); (3) by filling the undercut with movable pieces of plaster, technically known as "false cores." They should be so shaped as to admit

of being drawn from the sand; at the same time they must have a decided angle, so as to mark distinctly the place in the sand for their replacement. A small nail or tack in the sand, above the core, will keep it in place while the metal is being poured. (4) By making a sectional model (Fig. 820), as suggested by Dr. A. Westcott. It may be made by filling the central third of the wax impression with the plaster, keeping it from the lateral thirds by a temporary use of clay or putty. This is removed and trimmed, leaving the back wider than the face (Fig. 820); then replaced in the impression and filled up on each side with plaster; the model is then removed, properly trimmed, and varnished.

Dr. Bean's method of making a model in two parts is equally applicable to making models in three parts, and is perhaps better

Fig. 820.

Fig. 821.

than the foregoing. He thus describes it: "To secure a division in the model itself, the best plan is to set up in the impression a septum of thin sheet lead, forming a vertical plane in the median line of the palate, and fitted somewhat to the inequalities of the impression. This plate should have two or three small projections struck up on one side, by means of a small conical punch, and the opposite side has some cotton fibre attached with shellac, in the manner described for preparing impression cups. Fig. 821 represents the shape of this plate (one-half the size), and shows the side on which are the projections. Its proper position will be readily understood when applied to an impression of one of those deep palates now under consideration. The side having the projections is oiled, the cotton on the other side wet with water, and while filling up the impression, this plate is set up in the middle, along the

median line, so that when the model is trimmed to proper size and shape, it may be carefully broken apart and placed together again in the same position."

Much time may be wasted in the effort to overcome difficulties of undercut in sand moulding. The dexterous removal of shallow models will suffice for most cases of front undercut; and of all others, it may be said that no undercut on the die is of any service into which the plate cannot be swaged, or in removal from which the plate is apt to be bent.

Removing the impression is a fruitful source of vexation, because of the frequent breaking of prominent parts of the model and other annoying accidents. But these are in every case the result of haste, carelessness, or forgetfulness. First, the model must have time to harden; then the impression, if of wax or gutta-percha, must be thoroughly softened. The common practice of setting the model on the stove is bad; the smell of burning wax is often the first warning of a softening which has gone too far, injuring the model by the absorption of melted wax. It is far better to place it in water at 140° and 150° Fahrenheit, leaving it long enough for the entire mass of wax to soften; at this temperature the wax does not melt, yet is so soft that it cannot injure the most delicate point of the model. If over 150°, some portions may adhere to the model and give trouble in removing. Gutta-percha impressions must be thoroughly softened in water at 200°; if over this temperature, portions of gutta-percha are apt to adhere to the surface. In partial cases it is a good plan to first remove the cup, then turn up the edges of softened wax or gutta-percha, till it is free from the teeth, and then remove the entire mass.

Plaster impressions require a different treatment. If the cup is wholly or partly of wax or gutta-percha, these must first be softened and removed; a Britannia cup is loosened by light strokes of the plaster knife handle. The impression is then broken away piecemeal. Dipping it in hot water makes it rotten, and facilitates, at times, its removal. It is often necessary to cut nearly through the impressions in places, in doing which the knife or graver must be held so as to guard against injury to the model beneath. Another safeguard is to coat the impression, before pouring, with oil colored by alkanet; or, better still, to tinge the plaster with which the impression is taken with vermilion or Brandon red; it gives the dry plaster a faint pinkish tinge; does not, in this small proportion, injure its setting qualities; and it makes a very distinct contrast with the pure white of the model.

Few impressions can be used twice; those taken in wax or gutta-

percha cups, never. Partial impressions of all kinds are necessarily sacrificed to the integrity of the first model. But plaster impressions, in a smooth Britannia cup, may, with proper care, be replaced in the cup, and used again so as to give a model quite equal to the first. Some of these will come from the model entire; but often it is necessary to cut a groove over the alveolus, and break off the outer rim in two or three sections.

Models may be partly trimmed before removing the impression, but it is always necessary afterward to trim the shoulder. Usually this is done by merely taking off the rough edges, following the outline of the edge of the impression; but for striking up a plate with the outer edge turned up, a flange, or shoulder, about the fourth of an inch wide, is formed around the outside of the plaster model, where it is designed that the edge of the base plate shall terminate on the alveolar border. It may be shaped either in wax or plaster, and should stand off from the ridge at an angle of about 90° or 100°, the angle of the rim being completed with pliers after swaging. A plate swaged with such a rim is used in mounting gum or block teeth and in continuous gum work; it is stronger than a simple plate, and is susceptible of a more beautiful finish. For a lower set of block teeth, the edge of the plate may also be turned up all the way round. An objection to a swaged rim is the occasional difficulty of determining just how far over the ridge the plate should extend; for any change is impossible without destroying the rim. Hence the more common practice, except in continuous gum work, is to solder a gold band or wire, after adaptation of the plate to the mouth, as hereafter explained.

The model, if it is to be used in sand moulding, should have several coats of shellac or sandarach varnish applied with a small bristle brush, to give it a smooth, hard, and polished surface. This will protect it from injury by use, render it more pleasant to handle, and cause the sand to part easily from it. The gum shellac varnish may be prepared by dissolving five ounces of shellac in one quart of alcohol. In using this varnish on a damp impression, be careful not to apply a second coat until the first is hard, else it will cause the first to peel and injure the smoothness of the surface. Sandarach varnish is preferable to shellac, as it is harder; it is also more transparent, and, consequently, does not color the plaster. It may be made in the following manner: Take six ounces of gum-sandarach, one ounce of elemi; digest in one quart of alcohol, moderately warm, until dissolved; or the sandarach alone may be used. This is, perhaps, as good a varnish as can be used for plaster models.

It is easily prepared, but the alcohol should be warmed in a sand bath or hot water, to prevent it from taking fire. To make the finest varnish, the sandarach should be of best quality, and washed in water before being put into the alcohol. Some, however, prefer a coating of charcoal dust or plumbago or powdered soap-stone for sand models.

Models for dipping or pouring, or the fusible-metal process, should have no kind of varnish upon them. Vulcanite and other plastic work models may have a protecting coat of dilute soluble glass (nine parts water to one part of the glacial syrup); but if too much or too strong a solution is used, it will do more harm than good. No shellac or sandarach varnish should be applied to plaster models for either vulcanite or celluloid work.

For the preparation of the surface of the plaster model to overcome the difficulty resulting from a hard ridge or prominence in the centre of the palatal portion, the reader is referred to page 886.

CHAPTER IX.

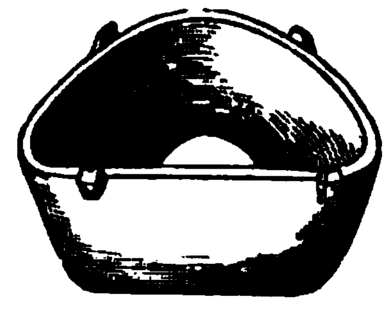
DIES AND COUNTER-DIES—SWAGING PLATES.

Various methods have been adopted for procuring metallic dies and counter-dies. The three following are all which the author deems it necessary to describe. The first of these consists in pouring melted metal into a mould or matrix, made in sand with the plaster model. By this means the die is formed, and the counter-die is obtained by pouring metal upon it. The second consists in making the counter-die first, either by immersing the plaster model in metal or pouring metal upon it; the die is formed by pouring metal into this.

The third consists in pouring the metal for the metallic die directly into the impression. A very ingenious set of flasks for this purpose, the invention of Dr. F. Y. Clark, can be had at the dental depots. The same may be done, less conveniently, perhaps, with the usual Britannia cups and moulding rings. Take a piece of copper or brass gauze, and fit into the cup before taking the impression. Set the impression, thus strengthened, into a batter (asbestos or sand three parts, plaster one part), poured into a narrow

iron ring (sheet iron will answer); carefully work the batter around the edges of the impression; then place upon it the zinc half of a Bailey flask (Fig. 822). If the impression is thoroughly dried, the first metallic die will be perfect, no matter how much undercut there may be. A second or third may then be taken, more or less defective, but very useful for the first stages of the swaging process. Zinc is the metal used by Dr. Clark for the die. In this process the impression may be plaster or plaster and feldspar; but the investing batter should have only enough plaster to bind the asbestos or sand together. Dr. Clark uses a copper impression cup, which Prof. Austen's process dispenses with. The flask and impression must be perfectly dry, and heated nearly or quite up to the fusion point of the metal used.

FIG. 822.



The second method admits of three modifications: 1. The *fusible-metal* process; in which the model is surrounded with thick paper, and fusible metal in a semi fluid state is dashed over it with a spoon, the model being cold, so as to rapidly chill the metal. While still warm, the paper is removed and the counter-die trimmed with a knife; for at this temperature it can be cut as readily as cheese. The counter-die, when cold, is then smoked or coated with whiting, surrounded with paper, and semi-fluid fusible metal dashed on it, to make the die. This process is repeated until from two to six dies are made, according to the irregularity of the case. The model should be in a ring of nearly circular shape and cylindrical; it should also be at least half an inch larger than the alveolar ridge, that the counter-die may have sufficient metal to force up the plate.

2. The *dipping* process consists in pouring melted lead, type-metal, or pewter into a sheet- or cast-iron cup or box, three and a half or four inches in diameter and three or four inches deep, until it is more than half full; then, stirring the fluid mass with gradually increasing rapidity until it begins to granulate, quickly brush off the surface dross, and at once immerse the plaster model more or less deeply, as the palate is a deep or shallow one, and hold it there until the metal congeals. To prevent accident from air confined in the palatine arch, a small hole should be drilled through the plaster model. It is then removed, and the whole upper surface of the counter-die covered with a thin coating of whiting or lamp smoke, as before directed. After this has become perfectly dry, melted block tin, type metal, or soft solder, at a temperature so low that it will not char, or even discolor white paper, is poured in, until the

cup is filled. If the counter-die is so deep that the die has not sufficient thickness, it may be deepened by placing on the freshly-poured metal the zinc half of a Bailey flask, and continuing to pour; the metal in the two flasks will unite and form one die When cold, the castings are removed from the iron cup, separated, and are then ready for use.

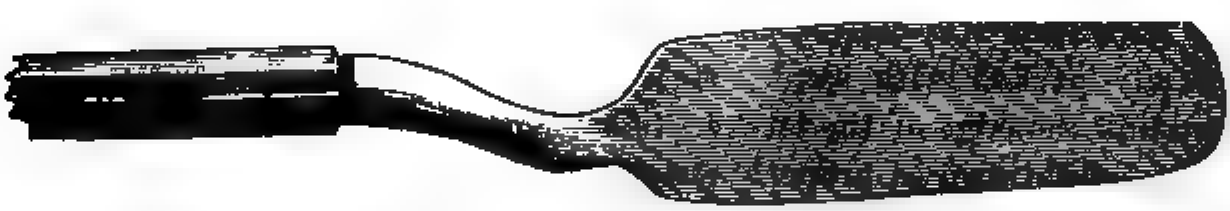
3. *Dr. Gunning's* method, called also the "pouring process," in which a very thin model (made of plaster two parts and sand or feldspar one part) is placed in the bottom of an iron box, three and a half to four inches in diameter and about two inches deep. It is fastened there by a thin layer of plaster and sand, then thoroughly dried by gradually raising box and all to the temperature of the melted metal, which is next poured in, and the box set in a shallow vessel of water to cool it rapidly from the outside. To delay the cooling in the centre until the last moment, and to prevent contraction at that place, a very hot pointed iron, somewhat similar in shape and size to a tinner's soldering iron, is placed upon the centre of the model before the metal is poured. When cold, this is removed and the conical space filled with metal. The counter-die is thus made of lead, alloyed with tin or type metal. The die is made by placing over this a stout wrought iron ring and pouring in fusible metal. Dr. Gunning uses from three to eight dies, according to the sharpness of the prominences of the model. The method gives, in his hands, very accurately fitting plates.

When metallic dies are to be obtained by the first method, moulding flasks and sand are required. Flasks may be of wood or iron. The moulding box of wood should be about six inches square. This is to be filled with fine sand, such as is used by brass founders, in the following manner: The deep or shallow plaster model is placed on the moulding table, exactly in the centre of the box, with its face upward. Sand is then firmly packed around the sides of the model. Sand should then be sifted, covering the face of the model to the depth of a half inch, the box then filled, and the whole rammed with a firmness proportioned to the coarseness or dryness of the sand—damp or very fine or strong (*i.e.*, with large percentage of clay) sand not permitting so much compression as sand possessing the opposite qualities, because it would become too compact to permit the escape of the vapors formed during the process of pouring. But the finest sand, rich in clay and quite moist, may be used if it is dried before pouring. Sand mixed with olive or sweet oil possesses some advantages over that mixed with water, as it can be used a number of times without re-mixing, prevents the bubbling common to sand made too moist with water. The sand should

never be burned by pouring on it very hot metal; hence, it is better to stir the metal until it has cooled somewhat before pouring it into the mould. The metal should not be injured by overheating. Cooling the die suddenly in water renders it brittle.

The box is then turned over and gently tapped several times with some light instrument or hammer, for the purpose of starting or detaching it a little from the matrix, and then carefully removed. Great care is necessary that this tapping does not depress first one side and then the other; this would make the die too deep in the centre, and perhaps cause the plate to rock. The model may be loosened laterally, by holding an excavator firmly upon the centre of the die and tapping it on the side. If the model be composed of three pieces, the middle section is first removed, and afterward the two others. There are two ways of drawing the model: first, by screwing it into an excavator or gimlet, and carefully drawing it out; second, by throwing it out with a dexterous jerk of the matrix. The last is best; the excavator is apt to break through the centre

FIG 823.



of the thin model, and the thick one falls out by its own weight better than it can be drawn. Fig. 823 represents the two ends of a double spatula, which will be found very useful in sand moulding.

If the deep model is used, the matrix is now ready for pouring; but first remove all loose sand, and make a groove at the back part of the matrix to receive the first flow of the metal. If the thin model is used, a ring must be set upon the sand after the model is drawn to give the additional size which the die requires to prevent cracking under the swaging-hammer.

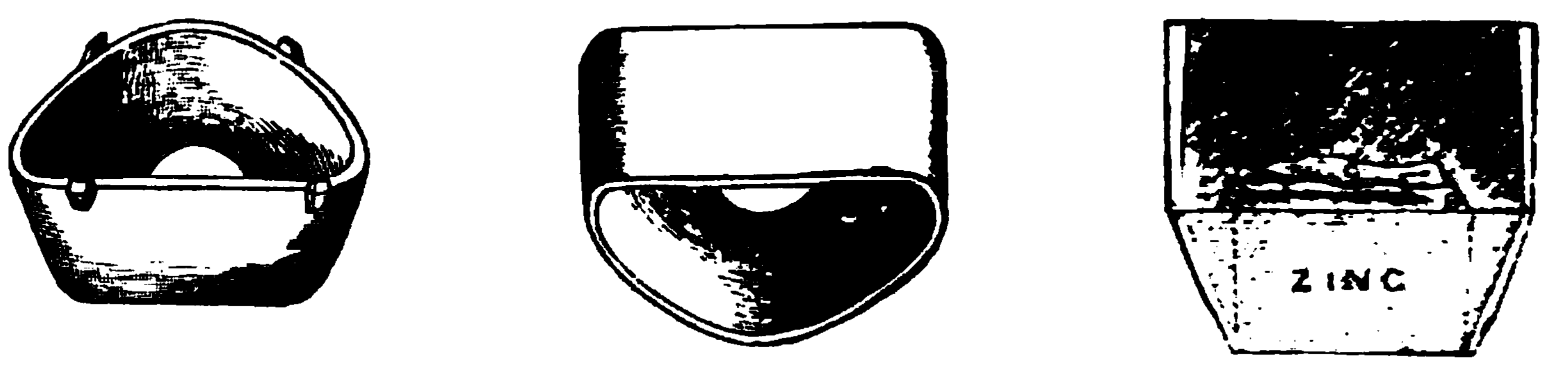
The mould being prepared, the metal to be employed for the casting should be put into a tolerably thick wrought or cast-iron ladle and melted in a common fire or furnace. Mr. Fletcher has invented a very useful melting apparatus, which is also suitable for drying and boiling purposes. If brass is used, a blast furnace will be required to melt it; but if zinc, block-tin, or lead, a common fire

will afford sufficient heat. As soon as the metal has become thoroughly melted it is poured into the furrow formed in the sand, whence it will flow into the back part of the mould. It is necessary to convey the melted metal into the mould in this way to prevent the injury which the surface of the sand might sustain by pouring directly upon it.

There have been quite a number of moulding flasks devised to supersede the wooden one just described or the common cart-wheel box, which was once much used. Some of these are worse than useless; others are very convenient, and have the advantage of requiring only a small quantity of sand; also of permitting the sand to be dried, which cannot be well done in the wooden box. The simplest and perhaps best flask is that invented by Dr. E. N. Bailey. Fig. 824 represents the shape and working of this flask.

Fig. 824.

A B C



Half-flask B is placed, joint-edge downward, over a thin model, and firmly packed with sand. It is then turned; the sand compressed around the edge of the model; then trimmed, so that the model may be easily drawn (a properly shaped model renders much sand trimming unnecessary); the model is then lightly tapped and thrown out. All operations on the thin model must be conducted with great care, for it is easily displaced in its matrix, so as to destroy the accuracy of the latter. Next, pour zinc into the mould, and at once place on half flask A, and complete the pouring. When cool, remove the sand, invert the flask, with zinc die contained, and pour the lead (C) upon the zinc for the counter-die.

In cases of moderate undercut in front, the thin model can generally be drawn by a dexterous backward movement. But for a deeper undercut in front, also for those at the side, the moulding flask of Dr. Hawes (Figs. 825, 826, 827) will be found useful. In Fig. 825 the lower section of the flask is slightly opened to show joints. In Fig. 827 the upper section. In Fig. 826 the lower section is closed and confined by a pin, with the plaster model placed in it.

The manner of using is thus described by Dr. C. C. Allen: "If

the model be considerably smaller than the space between the flanges projecting inward, small slips of paper may be placed in the joint, extending to the sides of the model, so as to part the sand when opening the flask for the removal of the pattern. The sand may now be packed around the model up to the most prominent part of the ridge. It should be finished smoothly around it, slightly descending toward the model, so as to form a thick edge of sand for the more perfect parting of the flask. The sand and face of the model must now be covered with dry pulverized charcoal, sifted evenly over the whole surface. When this is done, the upper section of the flask is placed over the lower and carefully filled with sand. It is then raised from the lower one, which may now be parted by re-

FIG. 825.

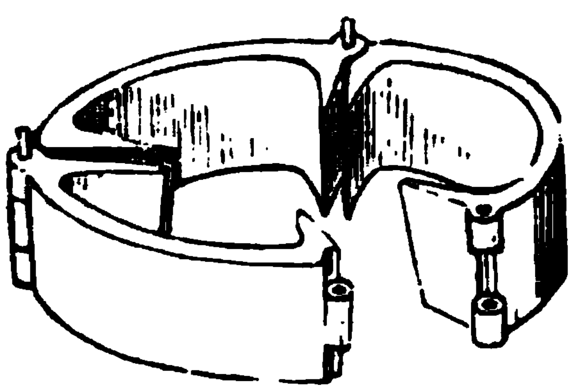


FIG. 826.

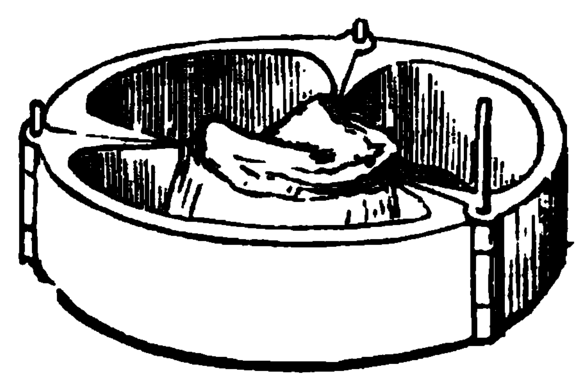
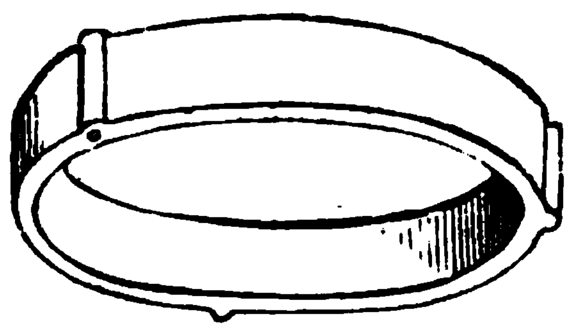


FIG. 827.



moving the long pin, and the model gently taken away. When closed, and the two put together again and inverted, it is ready to receive the melted metal." After the metal has cooled, it may be removed and turned over, so that the face of the die shall be upward, while the remainder is buried in the sand. Thus placed, it is encircled with the ring (Fig. 827) and the metal for the counter-die poured upon it.

The metals most commonly used, when metallic dies are made by sand moulding, are zinc and lead. For many reasons, these are, perhaps, the best metals for general use that can be employed. Zinc is the hardest metal that the dentist can conveniently melt. In case of deep or large arches, and for mouths where the mucous membrane is very hard, should its shrinkage prevent the close adaptation of the plate, a finishing die may be made of block tin, type metal, soft solder, or Babbitt metal (a patent alloy of copper, tin, and antimony, the best formula for which is Dr. Haskell's:

copper, 1 part; antimony, 2 parts; tin, 8 parts), which last is nearly as hard as zinc and has decidedly less shrinkage. When a metal softer than zinc is used, several dies will be necessary to complete the swaging. As this Babbitt metal fuses at a lower temperature than lead, it is necessary to use a counter-die in which tin forms a part; Dr. Haskell therefore recommends the following formula: lead, 5 parts; tin, 1 part. The die should be coated with whiting solution before pouring the counter-die.

The late Prof. Austen, by careful experiment, found that an average-size zinc die, measuring two inches transversely, contracts $\frac{27}{1000}$ of an inch from outside to outside of the alveolar ridge, being equivalent in thickness to three ordinary book leaves. He remarks: "In the first case (upper jaw), the plate would 'bind,' and if the ridge were covered by an unyielding mucous membrane, it would prevent accuracy of adaptation. In the second case (upper jaw), the plate would have too much 'play,' and consequently lack stability. Again, in a moderately deep arch, say half an inch in depth, the shrinkage between the level of the ridge and the floor of the palate will be nearly $\frac{7}{1000}$—rather more than one leaf. In the deepest arches this shrinkage may give trouble, except where the ridge is soft, and then it becomes a positive advantage. In the shallower cases, it is not of much moment, as there is no mouth so hard as not to yield the $\frac{1}{1000}$ or $\frac{2}{1000}$ of an inch."

A counter-die should be soft. When but one metal is used, lead is decidedly the best metal for this purpose; tin may also be used if the die is made of zinc, but tin counter-dies are only employed for the final swaging, and after the use of lead counter-dies. It is desirable, if practicable, that the metal last poured (in sand moulding, this is the counter-die) should melt at a lower temperature than the other. In this respect zinc and lead are admirably suited—zinc melting at 770° and lead at 600°. Tin melting at 440° might be supposed, in this respect, better than lead; but such is not the fact, owing to the tendency of tin and zinc to form alloys, while lead and zinc have no such affinity.

The requisites for a die are non-shrinkage, hardness, strength, smoothness of surface, and fusibility at a low temperature. The Babbitt metal after the formula before given furnishes such qualities.

Fig. 828 represents an excellent gas furnace for melting and refining gold and other precious metals and for melting zinc, lead, etc., of the baser metals. Fig. 829 represents a sectional diagram of the same furnace. In using plumbago crucibles, etc., they must be heated slowly when first employed. Mr. Fletcher's small gas fur-

nace, which is well adapted for melting the metals employed for dies and counter-dies, is represented by Fig. 830.

In a paper on metallic dies, published in the fourth volume of

FIG. 829.

FIG. 828.

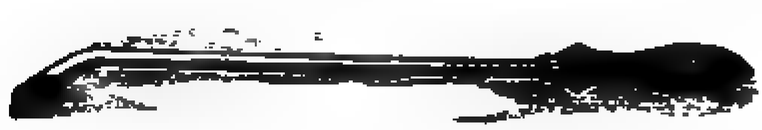
B

A

C

the *American Journal of Dental Science*, Prof. Asten gives, as the result of careful experiment, the following tabular view of the

FIG. 830.



fusible alloys—zinc being introduced for the purpose of comparison :—

	Melting Point.	Contractility.	Hardness.	Brittleness.
1. Zinc, ...	770°	.01866	.018	5
2. Lead, 2; tin, 1, ...	440°	.00683	.050	3
3. Lead, 1; tin, 2, ...	340°	.00500	.040	3
4. Lead, 2; tin, 3; antimony, 1, ...	420°	.00438	.026	7
5. Lead, 5; tin, 6; antimony, 1, ...	320°	.00568	.035	6
6. Lead, 5; tin 6; antimony, 1; bismuth, 8,	300°	.00266	.030	9
7. Lead, 1; tin, 1; bismuth, 1, ...	250°	00066	.042	7
8. Lead, 5; tin, 3; bismuth, 8, ...	200°	.00200	.045	8
9. Lead, 2; tin, 1; bismuth, 3.	200°	00183	.048	7

The last column contains an approximate estimate of the relative brittleness of the samples given. As in the other columns, the low numbers represent the metals, so far as this property is concerned, most desirable. Those marked below 5 are malleable metals; those above 5 are brittle; zinc, marked 5, separates these two classes, and belongs to one or the other according to the way in which it is managed.

In all cases of melting it is a safe rule to pour the metals at the lowest temperature at which they will flow. It is prudent, also, to coat the metal on which other metal is poured with a mixture of alcohol and whiting, to prevent all chance of adhesion. One more very important caution in the melting of zinc and lead is invariably to use separate ladles; for any lead left from a previous melting flows from the ladle with the last portions of the zinc, and, being heavier (in the proportion of 11 to 7) and more fluid, falls at once to the bottom of the matrix, making the alveolar ridge more or less of a soft metal, thus totally destroying its usefulness.

The elastic vapor generated by the contact of the water in the sand with the hot metal sometimes collects under or rises through the metal, and renders the casting more or less imperfect. This may be prevented: 1, by drying the sand; 2, by using coarse or loosely-packed sand and avoiding too much moisture; 3, by mixing the sand with oil instead of water. The slightest moisture on one metal, previous to the pouring of another metal upon it, will make the latter imperfect. The following method has been suggested to overcome this difficulty: "To prevent imperfections or bubbles in the palatal portion of metallic dies, it is not necessary to dry the mould after it is formed, or to use more than ordinary precaution as to the heat of the metal. The best result is obtained when the plaster model is quite thick and the mould consequently deep. This is then tipped forward, raising the back part or condyles to the highest point possible; pouring the metal in at the

front slowly, and lowering the mould at the same time until the palatal portion is covered and the mould filled to the top." The use of oiled sand, however, as before remarked, will prevent imperfections by bubbling on the palatal portion of the die.

In making metallic dies for partial cases, about three-fourths of the crowns of the teeth should be cut from the plaster model before using it for moulding. The plate can be fitted more easily and perfectly than can be done when the teeth remain on the plaster model and zinc die; for, in the former case, the plate need not be cut to fit the teeth until it has been swaged, while in the latter this must be done first; consequently, in striking it up, it will be drawn to a greater or less distance away from them. There is also danger of splitting the plate, in swaging it into the spaces between the teeth, if these are left on the metallic die. Half or partial counter-dies adapted to the palatal portion of the die only, and not extending quite to the ridge, are useful in the case of a deep arch, and prevent the plate from tearing during the swaging process.

We shall conclude the section on metallic dies by giving some practical suggestions by Prof. Austen on the properties and uses of the metals and alloys employed for this purpose.

Many of the properties of these metals, though most interesting, are not practically useful to the dentist; but there are some points, for which he usually refers to his memorandum book, that should be printed on the page of his memory. The following tables present two properties of certain metals in a form convenient for memorizing; although not absolutely accurate, they are quite enough so for use in the dental laboratory:—

Order of Fusibility.		*Order of Specific Gravity.*	
Copper,	2000°	Lead,	11.5
Antimony,	900°	Bismuth,	10.
Zinc,	770°	Cadmium,	8.5
Lead,	600°	Tin,	7.5
Bismuth,	500°	Zinc,	7.
Tin and cadmium,	440°	Antimony,	6.5

In the fusibility table, copper is given to show how unsuited it is for laboratory use. Remembering that 900° is *red heat*, the next four numbers may be easily memorized. In the specific gravity table, copper 9. and iron 8. are omitted, so as to present the table in a form easily remembered.

The only pure metals suitable for a die are zinc and tin; for a counter-die, tin and lead. When one metal is used for either die or counter-die, zinc makes the best die and lead the best counter-

die. Copper is too hard to fuse; antimony and bismuth are too brittle; cadmium is too expensive. All other metals used in swaging are alloys.

Zinc and lead are valuable because: They are so unlike that they are not easily mistaken for each other; a very common error when alloys are used. They have no such disposition to alloy as zinc and tin or tin and lead have. Zinc is so hard, one die will suffice for many cases; three are sufficient for the most difficult. The brittleness may be corrected by the size of the die. Its shrinkage is often a decided advantage; and in some cases, where it makes the plate bind on the aveolus, the contraction may be anticipated by coating these parts on the model with one or two layers of very thin plaster. Zinc, after repeated use, becomes defective, hence, a supply of new metal should always be kept.

No metal used alone equals lead as a counter-die. Its weight and softness are in its favor for this purpose. A counter-die cannot be too large or heavy; convenience, of course, limits its size. A difficult plate cannot be swaged with a small counter-die, unless the work is nearly completed by partial counters, hammers, etc., before using it. As regards softness, the greater the disparity between die and counter, the less will be the change in the die by the act of swaging. The plate is forced by the counter into the depressions of a die, not so much by its hardness, as by its *vis inertia* under the swaging blows. The little disparity in the hardness of the two dies is one serious objection to the use of the second class of operations. It is a common practice to use several counters, and perhaps only one die. One die may in a few cases suffice; two are better, and often three; but good swaging never demands more than one counter-die, where that is properly made.

With zinc, lead, and one fusible alloy (tin and bismuth, equal parts, or Babbitt's metal), all swaging operations may be completed when the dies are made by sand moulding or by pouring zinc into the impression. But since many prefer other methods of making dies, it is important to understand the subject of alloys. Experiment is here the only basis of knowledge, for no *a priori* reasoning could deduce the singular changes caused, and new properties developed, by alloying.

The alloy of two brittle metals is always brittle, and a brittle metal usually imparts this property to a tough one nearly in proportion to its percentage. But that two tough metals can make a brittle alloy is remarkable. Malleable copper, with half its weight of brittle zinc, gives hard brass, which, though less tough than copper, is not brittle. But malleable copper, with malleable tin in the

same proportions, makes speculum metal—the most brittle alloy known. A similar instance is that of lead, the softest of metals, which will, in minute quantities, make gold, the most malleable of all metals, very brittle.

Another remarkable property of all alloys is fusibility. Alloys fuse below the average melting point of their constituents. Ternary compounds exhibit this more strikingly than binary. The following table, in illustration of this property, will be found practically useful to the dentist in the selection of alloys:—

ALLOYS OF BISMUTH, LEAD AND TIN.

	BISMUTH, 500°.	LEAD, 600°.	TIN, 440°.	FAHRENHEIT.
1		10	1	540°
2		5	1	510°
3		2	1	440°
4		1	1	370°
5		2	3	335°
6		1	2	340°
7		1	5	380°
8	1	4	4	320°
9	1	2	2	290°
10	1	1	1	260°
11	2	1	1	220°

It will be noticed that two pounds of lead do not make one pound of tin harder to melt; whilst a half pound reduces its fusion point 100°. Also, Nos. 6 and 7, though containing more tin than No. 5, are harder to melt. Again, a pound of bismuth added to alloy No. 4 reduces its melting point 110°. No. 11 and all alloys containing much bismuth are brittle. The alloys of this table vary somewhat in hardness, but all are harder than tin.

The "alloying metals" of the dental laboratory are copper, antimony, and bismuth. Copper gives hardness to zinc and tin, and is sometimes combined with alloys of the two. But the high fusion point of copper renders it less useful to the dentist than the other two metals. The alloy of copper, antimony and tin (Babbitt metal) is perhaps the only one of practical interest. Its advantage over zinc, in being less liable to contract, is perhaps set off by the tendency of most alloys to change their composition by frequent melting; and the danger of mixing different alloys, from absence of such distinctive marks as separate zinc and lead.

Antimony is a more valuable alloying metal. It hardens tin, but its chief use in the laboratory is to harden lead, making type metal. Small types composed of lead 4, antimony 1, are too brittle; and large

types, lead 6, antimony 1, are scarcely fit for laboratory use. In the proportion of 9 to 1, antimony corrects the excessive contraction of lead and hardens it; yet leaves it tough so as to resist the blows of swaging. It is suitable only for counter-dies.

The very common opinion that antimony causes lead to expand on cooling is erroneous. The alloy has a slight expansion at the moment of solidification; but after that it obeys the universal law of all metals, and contracts as it cools. Actual contraction depends upon the ratio of contraction and the fusion point; thus, lead contracts more than zinc because its high ratio of contraction more than compensates its lower fusion point.

Another common error is that a zinc die poured very hot is smaller than if poured at its fusion point. Of course, contraction begins the moment cooling begins; but so long as the metal is fluid it necessarily fills the matrix, and contraction causes simply subsidence of the metal. No die begins to leave the walls of the matrix until it solidifies; hence, the amount of contraction is the same in all cases. Very hot zinc copies minutely the sand surface, and thus has not that bright, smooth appearance of cooler zinc, which sets before penetrating the sand interstices; but both are equally good. Another difference is in the greater depth in the cavity on the back of the hot-poured die. But this is not as objectionable as many think; no good mechanic strikes directly upon the die, but upon some ovoid or conical piece of metal covering the cavity in the back.

Bismuth is perhaps the most valuable, to the dentist, of the three alloying metals. Antimony gives hardness, but not much fusibility; bismuth gives fusibility, but no great hardness. The table above given shows the marked effect of this metal. It is seldom used as a binary alloy, because its fluxing qualities are more fully brought out in ternary combination; also because of its expensiveness, and its tendency to impart brittleness. Type metal is rendered more fusible by the addition of .05 per cent. of bismuth.

Bismuth, antimony, and zinc are readily distinguished—bismuth by its great weight and characteristic pinkish color; antimony by its peculiar crystallization and its excessive brittleness. But the alloys of these metals with tin and lead have such a general resemblance, that they must, with much care and system, be kept apart in properly labeled boxes; otherwise, if more than one alloy is used, the annoyance caused by using one for another will more than offset their utility; in fact, such negligence defeats their usefulness.

But the formula of Dr. L. P. Haskell for preparing the Babbitt metal is superior to all others for use as a die: Tin, 8 parts; copper,

1 part; antimony, 2 parts. For a counter-die for such a die: Lead, 5 parts; tin, 1 part. He claims that such a Babbitt alloy for the die cannot be excelled.

Dr. C. J. Essig recommends zinc for a counter-die for swaging a plate of platinum-gold or iridium-platinum; and also that such a counter-die is of especial service in partial cases where a number of teeth remain. For difficult swaging he recommends three sets of dies and counter-dies, the most imperfect of the dies being furnished with a lead counter-die, to be first used, and the next in quality to be used with a zinc counter-die, and the nearest perfect of all with a lead counter-die as a finishing die.

The following mechanical instruments will constitute an outfit:—

FOR METAL WORK.

Two pairs of shears, one straight and one curved.
Wood or horn mallet.
Hammer for swaging.
Hammer for riveting.
Rivet punch forceps.
Saw-frame and saws.
Round and half-round files.
Plate-nipping forceps.
Plate brush.
Round and flat pliers.
Solder tweezer.
Long soldering pliers.
Two melting ladles.
Sieve and rammer.
Moulding boxes, or flasks, and rings.
Soldering block, plumbago, asbestos, or pumice.
Glass plate for borax.
Soldering-pan.
Small vise and anvil.
Ingot-mould.
Crucible and tongs.
Reamer.
Blowpipe.
Lathe and appliances.
Melting furnace.
Metal articulators.
Acid dish, lead or copper.
Plate burnisher.
Soldering lamp, gas or alcohol.
Polishing brushes, hand and lathe.
Burrs, drills, and circular saw.
Rolling mill.
Cutting pliers.
Bending pliers.
Plate gauge.
Plaster knife.
Plaster spatula.
Plaster bowl.
Tooth-holder in grinding.

FOR CONTINUOUS GUM-WORK.

To the above may be added: Furnace with muffles, slides, and tongs; soft and stiff brushes; carving and modeling instruments.

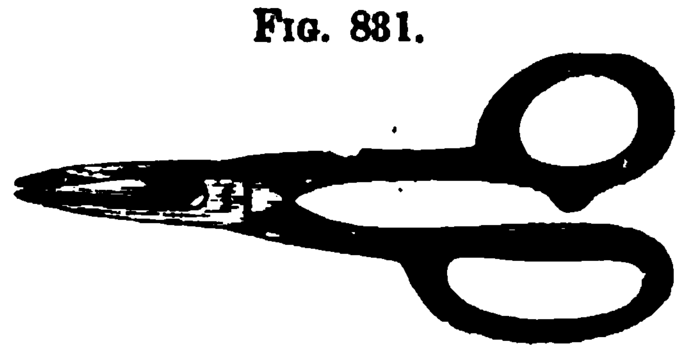
FOR VULCANITE AND CELLULOID WORK.

Vulcanizer, or vulcanizer and heater combined.
Flasks for vulcanite.
Flasks for celluloid.
Scrapers.
Wax spatula.
Packing instruments.
Flask press.
Chisel or graver.
Rubber files.
Callipers.
Varnish bottle.
Oil bottle.
Scotch-stone.

SWAGING.

A die and counter-die having been obtained, a piece of tin foil or sheet lead is adapted to the former, and the dimensions of the plate marked upon it. Paper is sometimes used for this purpose, but is not so good as thin sheet lead or heavy tin foil. The pattern thus made is cut out, flattened and laid upon the gold plate, and its outline marked upon it. The outline of the plate may be marked on the plaster model and the pattern cut in conformity therewith. The margins of the plate for the upper jaw should extend as high as possible, and especially over the position of the canine teeth, in order to restore the expression, which is greatly changed by the loss of the natural teeth at such joints; back of the canine teeth the margin of the plate should be lowered so as to avoid the attachment of the muscles and to allow the latter free motion or action. The plate should also embrace the maxillary tuberosities in order to obtain stability, and the margins at such points may extend higher than over the bicuspids and first molars. The plate should be cut a little too large, to allow for trimming and any accidental slipping upon the die. In partial cases the pattern should be carried partly, or fully, over the excised teeth, and no attempt made to fit it accurately around the necks of the teeth until the swaging is nearly or quite completed. With a pair of strong shears the portion of plate thus marked is cut out. Fig. 831 represents a pair of shears, with long and conveniently-shaped handles. The blades of some shears are curved laterally; but this form is not desirable. A fine watch-spring saw, Fig. 548 (p. 738), should be used for curves which the straight shears will not cut; curved shears may also be used for such a purpose; for very short curves—around teeth, for instance—a pair of cutting forceps will be found useful.

FIG. 831.

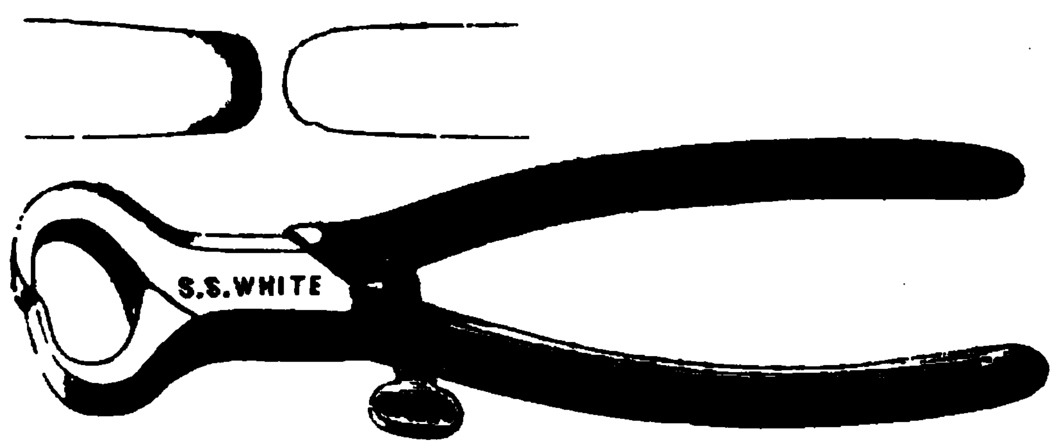


Figs. 832, 833, and 834 represent nippers or cutting forceps for cutting out plate.

Cutting plates to shape before swaging is, however, not only unnecessary, but is in many cases a positive disadvantage. Swaging the square plate is greatly preferable in the lower jaw, since it permits working from the centre outward. And in both upper and lower plates, the two triangular pieces outside the ridge help to prevent plaiting, or doubling of the plate. Purchased plates are ordered to pattern on the score of economy; but the difference is trifling, since

good plate scrap has nearly the same value as the original plate, and every careful operator separates his plate scrap from his solder scrap and filings. After swaging is nearly completed, with partial

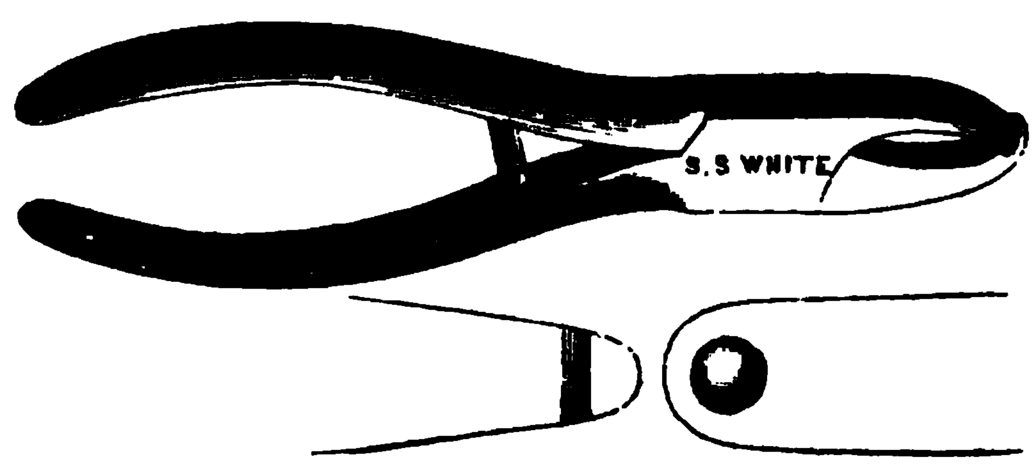
FIG. 882.



counters and hammers, the square plate may be quickly trimmed to shape by means of a jeweler's saw.

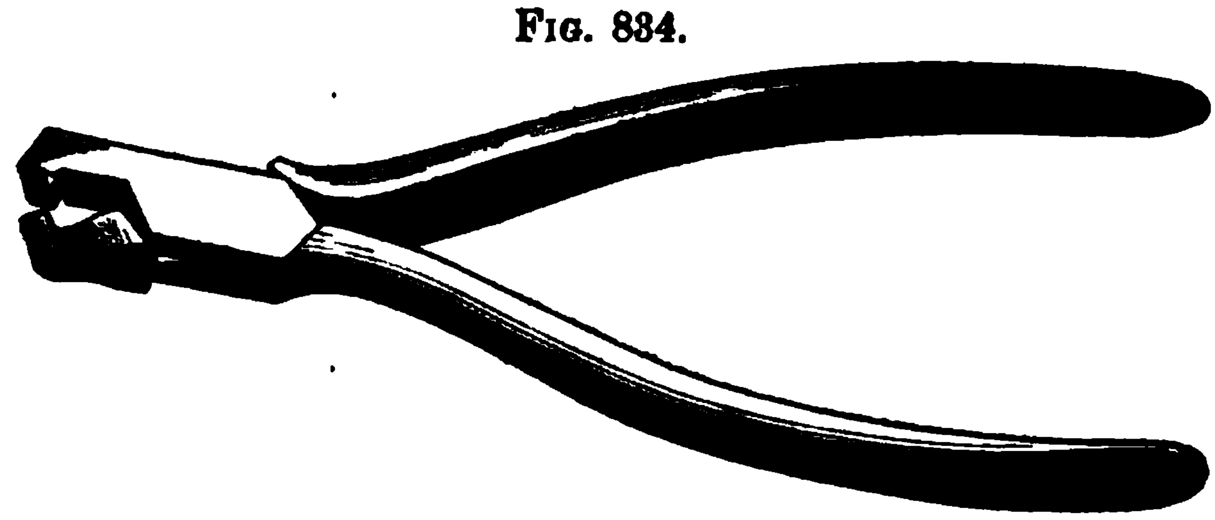
The plate must be well annealed and partially fitted by wooden, horn, or leaden hammers to that part of the die inside the ridge.

FIG. 883.



There is no better hammer for this purpose than lead; but, of course, the plate must be thoroughly cleansed of all trace of the lead before annealing. The swaging is continued by the use of *par-*

FIG. 884.



tial counter-dies; these are made by placing a rim of clay or putty around the ridge and back part of the metallic die, and pouring on it fusible metal. In this way the plate should be perfectly fitted

so far as the ridge. Then, clamping the plate between the die and the partial counter, the edge is to be gradually carried over the top and outside of the ridge with hammers and small wooden or ivory stakes. The plate may be clamped in a vise, or by means of a string passing over the die and under the foot; but a much more convenient method is found in the use of Dr. T. H. Burras's clamps, Fig. 835. Of the two forms here given the sliding arm (No. 2) is preferable to the long screw (No. 1). The application of the clamp is so plainly shown in No. 1 that any description is unnecessary.

It is the practice of some to cut out V-shaped pieces from the front or back part of the plate, to prevent the plaiting of the metal.

Fig 835.

No. 1. No. 2.

This is very bad practice and is never called for, if due care is used in swaging and the metal is of proper fineness. To avoid plaits or folds, anneal often, and in deep arches carry the plate down very gradually; also take care in such cases that the plate be thick, to allow for stretching or drawing. In swaging over the ridge, it is a very common mistake to hammer down the outside before fully striking up (with hammer and stakes) the parts nearest the partial counter-die. Always make it a rule, in carrying the plate over the ridge, to swage from the centre outward; carry the plate "home" as you proceed. In deep arches, irregular alveolar ridges, and in prominent lower ridges, swaging must be done slowly and with great care.

In the use of forceps for bending lower plates (Fig. 836), care must be taken not to bruise the metal, as will any steel or hard metal instruments. There is no shape of arch or of plate which, by the above simple process, cannot be perfectly fitted with a 20-carat plate. The elaborate forms of a window cornice or a jelly mould should teach any dentist how poor a mechanic he is when he complains of the difficulty of swaging so highly malleable a metal as gold into and over the irregularities of the mouth. And when, to save his skill, he pleads want of time, he exposes a graver deficiency—dishonesty.

The fitting of the plate being thus almost completed by hammers and partial counters, it should be trimmed to its exact shape, and

FIG. 836.

then placed between a fresh die and the full counter-die, and carried "home" by several firm blows of the hammer, given directly over the centre of the die. The hammer should not weigh more than three pounds, with a handle about a foot long. It is a great mistake to use a very heavy or a very long-handled hammer. The striking-block may be an anvil, or a large wooden block set in sand or on a cushion, and the base of the counter-die must rest steadily upon it. Dr. Haskell describes a movable swaging-block to be kept under the bench as follows: "Eight inches wide at the top, and eleven inches at the bottom, just high enough to pass under the bench. Make it of pine with a plank bottom, to which attach heavy casters, a handle on one side, and a pocket for the hammer. Have an iron 6-inch cube cast, and filling the box nearly full of sawdust, place the iron cube in it so it will extend 2 inches above the box." It greatly facilitates swaging, and makes one independent of any striking block, to have a very thick and heavy lead counter. As there is always a hollow in the back of a zinc die, a conical piece of iron, steel, or other hard metal should be placed

upon it to centralize the blow of the hammer. An egg shell, filled with plaster, is useful as a model for making, at the time of moulding the die, several zinc blocks for this purpose. To a disregard of these precautions is due much of the difficulty so often complained of in the tilting or rocking of plates and dies.

Throughout the entire process of swaging the plate must be frequently annealed. It may be suddenly cooled after all except the final annealing, when the cooling must be very gradual, so as to avoid warping or springing. The malleability of gold plate will permit a great deal of swaging without annealing; yet the neglect of this simple operation is unsafe. One broken or cracked plate gives more trouble than the annealing of a dozen. The plate, after final swaging, must be taken from the counter very carefully, to avoid change of shape. Thin paper in the counter-die makes removal easier; it is also easier when only one counter is used. Too much swaging gives the plate a loose fit.

When block-tin, lead, or fusible metal dies or counter-dies are used in swaging the plate, any portion of these metals which may adhere to it should be removed before annealing, as their fusion upon its surface alloys them with the gold, and will render it brittle

Fig. 837.

and impair its ductility, or else eat holes in the plate at the spot where the particles of baser metal form an alloy, fusible at the annealing heat. This is done either by mechanical or chemical means. If acid is used, it should be dilute nitric, since sulphuric will not dissolve lead; but be very careful that the nitric acid contains no hydrochloric, else the plate will be acted upon. A copper or lead acid-dish may be employed, many preferring one made of thick sheet lead. Oiling the dies will also prevent the base metal from adhering to the plate, as any particles of the former can be readily wiped off.

The plate, in the case of a full upper denture, should be so outlined

as to have the highest portion of the rim over the cuspids, curving downward back of such points to the maxillary tuberosities, where it again should ascend so as to extend over these prominences. (Fig. 837.) Space should also be made for the frænum of the lip by cutting away the edge or rim for its reception. In the case of a full lower denture, the bending pliers may be used first, and its outline should be such that it does not interfere with the muscles and loose integuments. For a very flat ridge, the lower plate should be double to give strength, and for partial lower dentures it is better to double the plate where strength is required; strength is also secured by the plate, in such cases, extending above the necks of the teeth, in some instances half way, where the attachment of the muscles would otherwise necessitate a very narrow plate. Each piece of a double plate should be swaged separately, and the two parts then

Fig. 838. Fig. 839.

soldered together, wire clasps being used to hold them in position during the soldering process. If the denture is to be retained by clasps, the plate, either upper or lower, should extend at least one-fourth of an inch beyond the clasped tooth in order to secure stability. In soldering the two parts of a double plate, the edges of one should slightly overlap the other so as to facilitate the process.

Figs. 838 and 839 represent the general forms of upper and lower plates after the swaging process is completed. In the upper plate is represented the proper size and position of a vacuum cavity, whenever it may be thought proper to use one. The question of the cavity will be elsewhere discussed.

If on trial of the plate in the mouth it does not fit properly, the operator must proceed to ascertain the cause of failure. And, first, whether it is temporary or permanent. A plate which falls because it rocks over a hard palate will never improve; if because it fails to go fully into the palate, it may daily improve, and ultimately adhere with great firmness. Most plates made soon after extrac-

tion fit badly until the alveolar prominences are pressed down by wear. Some very hard mouths will not retain the plate until it has been worn for a time, especially if the mouth is very flat. Deep arches, or uniformly soft mouths, should retain the plate firmly from the first.

The use of pliers, except for bending the edge into some alveolar undercut, is an evidence of bad work. The back margin of upper plates, so often adjusted in this way, is much better fitted by scraping the model at the place where the plate should bind; this should be done to a depth proportioned to the softness of the membrane.

Much judgment is demanded in deciding upon the necessity for a new plate. The impression may have been badly taken, or with a material not adapted to the mouth. The dies may have been carelessly made, or the swaging imperfectly done. Trial of the plate is essential to ascertain all these points, that the articulation, soldering, etc., may not be so much additional labor in vain.

In fitting a plate, the operator should see that its posterior margin, especially at the centre, is so closely adapted as to exclude air. Dr. Haskell recommends wetting the plate before placing it in the mouth, and then by a "pumping process" watching for the escape of air bubbles. At the same time the plate should not press so hard at the centre of its posterior margin as to irritate the mucous membrane. To determine whether a lower plate infringes upon the muscles and lower integuments, the patient may be directed to raise the tongue, which will dislodge the plate if it so interferes by its depth. The lip can also be raised in front to determine if the plate extends too deep at that point.

The different forms of plates, full and partial, will hereafter be considered. They are retained in the mouth by clasps or stays; by the adhesion of contact or by the vacuum cavity, the retaining force being atmospheric pressure; by the elastic spring of the wings of the plate; by spiral springs. These will be taken up in a subsequent chapter and their relative merits discussed. We pass now to the step which, in swaged work, comes next in order to the fitting of the plate—the means for securing its exact relation to the natural teeth, or, in double sets, its relation to the opposing plate. These processes come under the technical head of Articulation.

CHAPTER X.

ARTICULATION.

THE term Articulation, as used in Dental Mechanics, comprehends several distinct operations, implied in the use of the terms (1) Articulating impressions; (2) Articulating plates; (3) Articulating models.

In many partial tests it is best, after fitting the swaged plate to the mouth, to take a wax impression with the plate *in situ*. This gives the precise relation of the plate to the adjacent teeth; and upon application of a model of the lower jaw, it gives the relation of the plate to the antagonist teeth. This and all other impressions of the *relation* of plates to the teeth or to each other in the mouth we call articulating impressions.

A base plate becomes an articulating plate when the articulating rim is attached which has the impress of its opposite rim or teeth. In swaged work it is the gold plate itself; in plastic work it is some temporary plate of tin, lead, or gutta-percha.

The articulating models make up what is technically called an "Articulator," of which there are many forms; all, however, comprehended under three varieties: (*a*) Those wholly of plaster poured into the articulating plates. (*b*) Those in which the model portion is poured into the articulating plates; but the back or hinged portion is metallic. (*c*) Those in which the original models are set into the articulating plates, and some complicated metallic articulator adjusted to them. Each of these classes have special advantages adapting them to various exigencies of practice.

Whenever, in partial cases, there are three points of contact sufficiently apart to give firm antagonism, Prof. Austen's plan was to take an impression of the lower teeth; this gives a model which antagonizes perfectly with the upper model, and makes the articulator without further trouble. This plan, specially applicable to vulcanite work, is adapted to swaged work by taking the articulating impression described in the second paragraph of this chapter. Such articulators require no backward extension or hinge, because the articulation is determined by the articulating cusps of the teeth.

In partial cases, where there are only one or two points of antagonism, and where, consequently, the opposition of the corresponding teeth would be uncertain, the necessity exists for some third point of support. This is best given by a backward extension of the model, so as to permit motion of the two halves of the articulator, some-

what resembling that of the natural jaws; though many partial cases do not require such an extension. In putting this wax rim on the plate it is better in all cases to trim it, as is done for full upper sets; but where there are remaining teeth the antagonism of these determines the proper closure of the mouth, and this is not essential. The plate and adherent wax are placed in the mouth; the patient is then requested to close the mouth naturally, imbedding the teeth of the lower jaw in the wax. While the mouth is thus closed, the wax on the outside of the teeth and alveolar ridge is pressed closely against them.

This done, the plate and wax impression are carefully removed, filled with plaster, and placed on a piece of wet paper, with the wax downward. The upper side of the plate is then oiled. As the plaster stiffens it may be applied until it is raised half an inch above the plate, and extended back of it on the paper an inch and a half or two inches. As soon as the plaster has set, its edges may be neatly trimmed; and at the back of the surface next the paper a deep transverse or T-shaped groove should be cut to serve as a model for the formation of a corresponding ridge on the half model with which this is to antagonize. This grooved surface must be coated with oil or soap water or varnish, or covered with a layer of tin foil or thin paper. Then partly fill the space inclosed by the wax rim with clay, putty, or wet paper, and pour on plaster to form the other half model. In running plaster into the wax impressions of the teeth, be very careful to avoid air bubbles and flaws, and do not oil the wax. After the plaster has set it may be trimmed as before directed.

Another and often more convenient method is to take a strip of sheet lead one and a-half inches wide, and bend it to the required outline of the articulator. Pour this partly full of plaster, and set the plate, previously filled with plaster, upon it. Cut the grooves as before described, and pour the other half of the articulator. The lead rim saves much manipulation and trimming, which, in the other case, the plaster requires. When the half last made has become sufficiently hardened, the two pieces may be separated, after softening the wax in warm water, and the wax carefully removed. The model is then varnished, for greater comfort in handling, and when put together may present an appearance exhibited in Fig. 840.

The artist has failed in this, and in other designs of the plaster articulator, to represent the tapering shape which it is best to give to the back half of the models, for greater convenience of holding them while adapting the teeth. The fault of many plaster articu-

lators is that they are too large and clumsily shaped. In any given case the proper distance of the groove or hinge is the distance from the patient's external auditory meatus to the line of the front teeth or alveolar ridge. The width and thickness of the articulator must vary with the size or depth of the mouth, avoiding any excess of plaster not necessary to give requisite strength.

For a full upper set, or where two or more remaining molars have no antagonism, it is a very common practice to place on the plate a roll of wax sufficiently large to receive the imprint of the lower teeth, and to prevent these from closing too far by the insertion of a piece of wood buried in the wax and projecting at the median line. The closure is better arrested by two lumps of sealing wax attached opposite the bicuspids, and trimmed to the required length

FIG 840. FIG. 841.

before putting on the wax. But the articulation ought to determine other points besides the single one of space. Hence the antagonizing plate should be made by adjusting a rim of wax corresponding in width to the length proposed for the artificial teeth, and trimming it until all the teeth in the lower jaw touch it at the same instant. Instead of wax, a rim of gutta-percha may be used to represent the required length and external fullness of the teeth. When this is satisfactorily adjusted, a small rim of soft wax is placed upon the wax or gutta-percha, and the mouth closed as naturally as possible until the teeth touch the latter. The gutta-percha can be readily trimmed with a sharp knife. Rims thus shaped give opportunity to ascertain, by the effect on the expression of the lips, etc., exactly what length and fullness of tooth suits the particular case. Gutta-percha is better than wax in arresting the closure of the teeth, and is decidedly best for the temporary articulating plates of plastic work; but the latter is more easily attached to a gold plate

and is more easily trimmed. By making the wax cold, or by imbedding a small block of wood opposite the bicuspids on each side, with the grain of the wood running transversely, for easy trimming, the wax rim offers a firm resistance.

There is a tendency on the part of the patient to close the mouth to one side, and nearly always to project the jaw too far forward; it is impossible to close it behind the natural articulation. The simplest method for regulating this is to keep the body erect and throw the head backward, so as to make as tense as possible the throat muscles, which thus act as a bridle, and almost compel a correct closure of the mouth. It may also be done by careful observation of repeated closures made by the patient while sitting in an erect natural position. The operator must avoid impressing upon his patient the necessity for an easy natural closure; such directions invariably defeat their object. Of course, these trials are to be made before attaching the soft wax which receives the impress upon the final closure. A vertical median line, traced on the wax, is of service in observing the articulation and in the subsequent adjustment of the artificial teeth. Fig. 841 represents such a rim with its original fullness cut away.

For a double set of artificial teeth the following method of articulation is often adopted. After having accurately fitted both plates, a rim of soft beeswax is placed between them, about an inch and a quarter in width. A piece of wood, exactly corresponding in width to the proposed length of the upper and lower central incisors, is passed through the wax between the plates at the median line; or, still better, one piece on each side between the bicuspid part of the plates. The whole is now placed in the mouth, and each plate accurately adjusted to the alveolar border. The patient is then directed to close the mouth until the plates are brought in contact with the edges of the interposed piece of wood. This done, the plate, wax, and wood are together removed from the mouth.

But a far better method consists in placing a rim of wax or gutta-percha on each plate, giving the length, outline, and fullness respectively designed for the teeth of each jaw. The two plates are put in the mouth, and the jaws are carefully closed; if the rims of wax touch at any one point sooner than another, the plates are removed and the wax trimmed; this operation is repeated until the two rims of wax meet all the way round at the same instant, and give the proper contour to the cheeks and lips. The median line is then marked, and the final closure of the mouth made with the utmost care, so that there shall be no lateral or forward deviation. The exact position being secured, the lower jaw is to be held with the

left hand, while with the right some six or eight oblique indentations are made with a wax-knife across the line of contact between the two rims. Some fasten them together by a warm wax-knife or by pins or by small slips of brass plate warmed and forced into the wax. The pieces are removed jointly or separately from the mouth; if separately, they can, by the aid of these marks, be accurately readjusted.

From these articulating plates a plaster articulator is made substantially in the manner described for a partial case. The lead rim for shaping the models will often have to be two inches broad. If the precaution is taken to fill the space within the wax rims and between the plates with paper pulp, it is not material which half is

Fig. 842.

filled first. Usually the lower-jaw model will be thickest, and in this, made first, it is best to cut the grooves. Fig. 842 represents a plaster articulator with the plates removed, in which figure, from neglect of this point, the thin upper half is much weakened by the V-shaped cut.

Partly to save plaster, but chiefly to permit modification of the articulation where inaccuracy is suspected, quite a number of metallic articulators have been recommended. One of the first contrived for this purpose was by Dr. Thomas Evans, of Paris, and made of heavy brass wire.

Fig. 843 represents a very convenient form of metallic articulator. But in using this and every similar contrivance the operator should remember that facility of changing the articulation, after the guiding wax rims are removed, is a very questionable advantage. It tempts to carelessness in articulating. Moreover, if the width of space or other relation of the parts is such as leads to suspicion of inaccu-

racy, any change of articulation is, at best, a sort of random guesswork. The most certain correction of surmised error is, undoubtedly, to take the articulation anew. Hence our preference is for the old-fashioned plaster articulator, with its unaccommodating fixedness,

FIG. 843.

that neither offers a premium on carelessness, nor puts the careful workman at the mercy of some loose joint or screw.

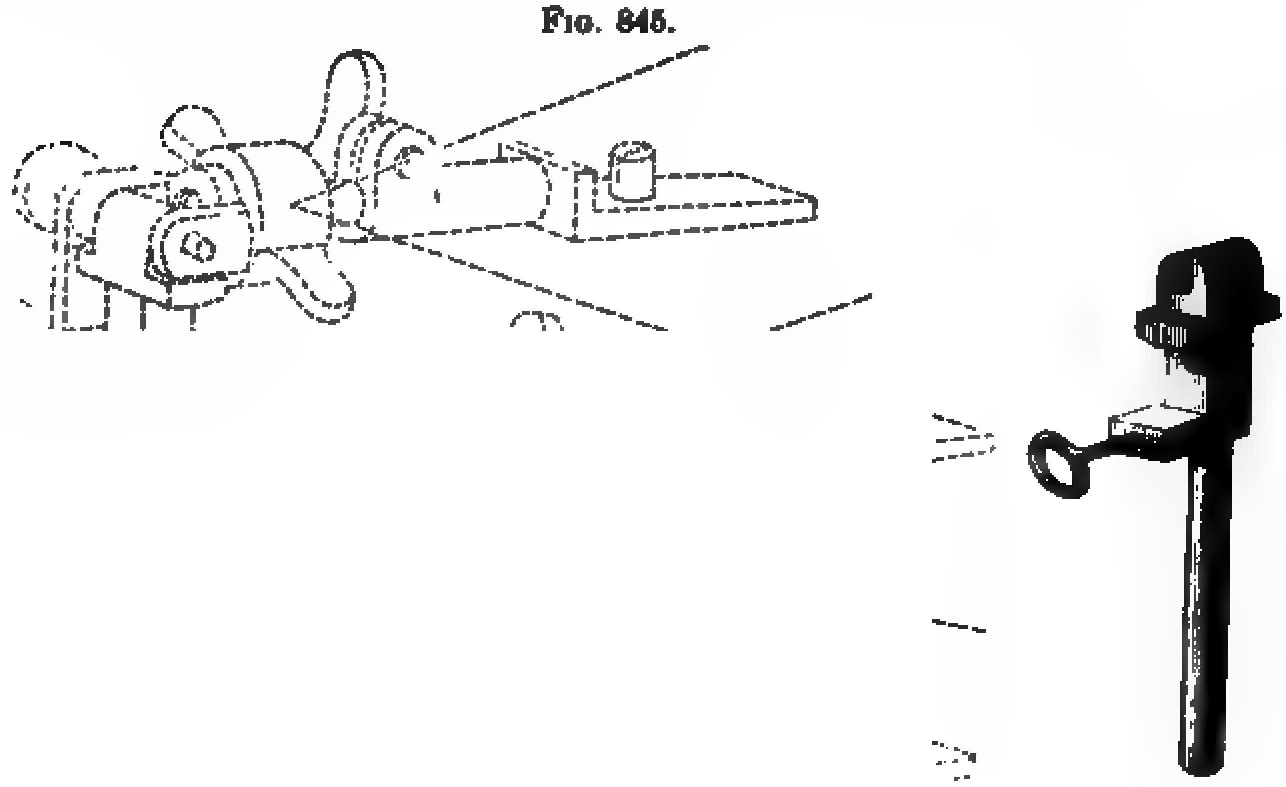
FIG. 844.

There is another class of articulators more complicated than the above, which are very useful in those cases where the original models are used, instead of special models cast in the articulating plates.

Fig. 844 represents an articulator devised by Dr. J. B. McPherson, the valuable feature of which is the clamping fixture for holding the plaster model. The danger of breaking frail models in removing them from the articulator is overcome, as they can be removed by simply loosening the clamp. It has also a lateral movement resembling that of the jaw.

Fig. 845 represents Dr. Genese's articulator, with set or lock pin and interchangeable model holders. The following directions are given for using this articulator: Detach the model holder, leaving the centre screw in; paint with non adhesive and arrange on a

FIG. 845.



board with the tube pointing away from the operator; after filling the impression cover the holder with plaster to the hilt and reverse, the tray uppermost. Let the centre of the impression be in a line with the tube at the back, making the model slightly higher in the back than ordinary models. When set, remove the centre screw and draw the holder out, wash in warm water, and it is ready for use again. The models can be trimmed and adjusted immediately they are hard. The entire instrument is never soiled with plaster.

To Secure a Bite for Future Reference.—This articulator, as it takes the bearings of the entire surface of both upper and lower models, without injury to them, and only a small quantity of plaster being

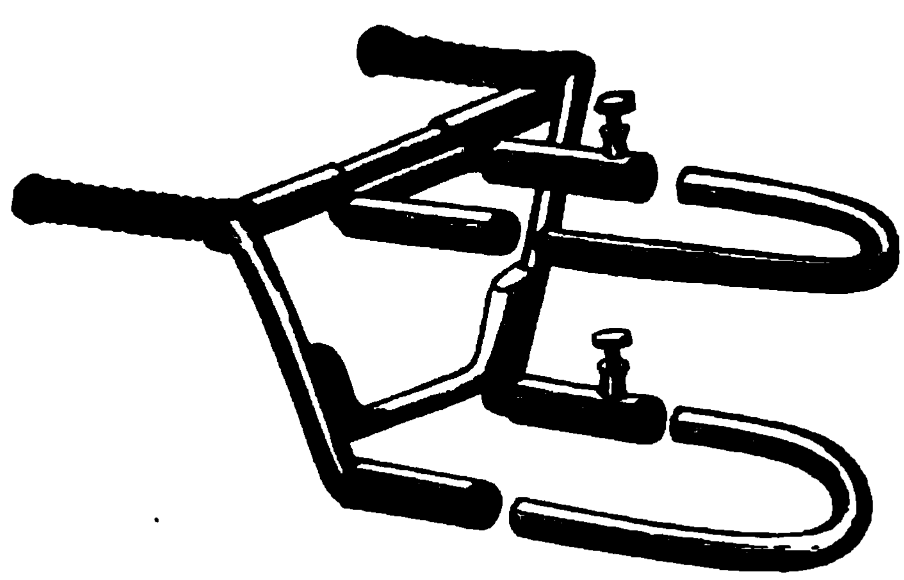
used, very little shrinkage occurs, and the bite can always be replaced on the articulator without the difference of $\frac{1}{1000}$ part of an inch.

To Arrange a Bite for Reference.—Paint the models with non-adhesive; mix some plaster and pour in tissue paper, and place between the models that are perfectly articulated previously; gently close the articulator until the pin enters its centre and allow it to harden; as soon as it is set, trim up, and it is then ready for any future work. Any overlapping edge or slender tooth may have a little wax or soft paper placed on it, to prevent the plaster binding too tight.

Dr. W. G. A. Bonwill, who has devoted much time to the study of the geometrical and mechanical laws of articulation, and devised an anatomical articulator (Fig. 846) in accordance therewith, treats this subject as follows:—

"We find from 28 to 32 teeth in each jaw, arranged in such manner that no two strike directly against each other, but antagonizing in

Fig. 846.



such a manner as to prevent the whole denture from becoming very irregular, which would be the case if striking one against another. By this arrangement, when one tooth is lost, the regularity of the arch is not interfered with. As necessary as this is in nature, it is not positively necessary to follow it in artificial work, although for the sake of harmony it should be done.

"It will be found in 95 per cent. of cases that the upper teeth project over the lower, and the depth of overbite varies as the depth of the cusps of the bicuspids are deep or shallow; and the ramus will be found to come upward and backward in relative proportion to the length of the cusps and the overbite.

"One point of very great importance has not been lain down in general or special anatomy—the peculiar tripod arrangement of the lower jaw forming an equilateral triangle.

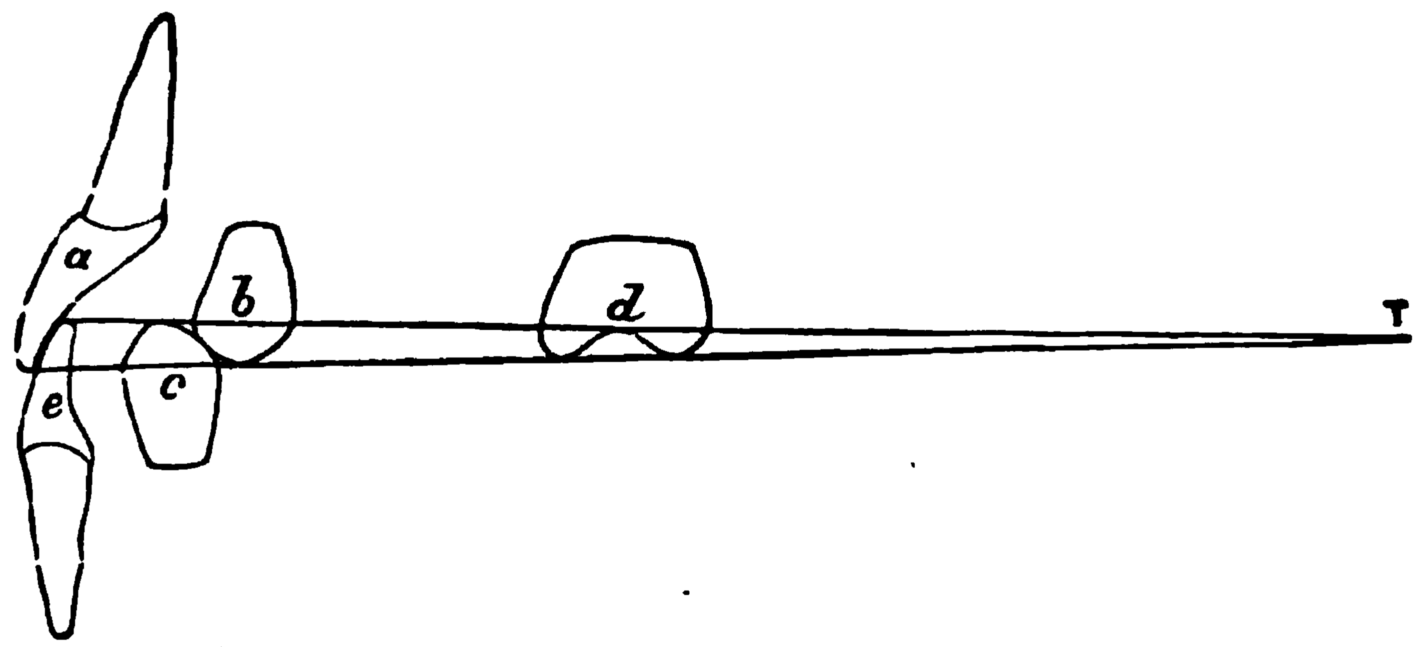
"From the centre of one condyloid process to the other, four (4) inches is about the average; and it will be found that from this same centre of the condyloid process to the median line at the point where the inferior centrals touch at the cutting edge, is also four (4) inches. It is strange it should have been overlooked; but it only shows, when studied in a geometrical and mechanical sense, the great wisdom in our formation. It varies slightly, but never more than one-fourth of an inch, which would make but a trifling difference in describing the arc of a circle. You will perceive that in setting your artificial teeth a one-fourth inch, the radius of the circle would not materially alter the articulation. Without such an arrangement the teeth would have to be flat on their grinding surfaces to admit of lateral movement. Besides, you would not have the beautiful and wise curvature at the ramus for equalizing the force applied to the teeth in all directions.

"Imagine the human jaw jointed at the pharynx, or as you see in the ordinary brass articulators. Do you suppose that there would be any greater wisdom displayed in such hinging or articulating a part destined to such varying motions and powerful wrenching force? No! The study of this one part of the head and jaws shows one of the most striking designs of a Great First Cause; and when studied you will see that every part of our frame is made by a positive law and to subserve definite purposes; such law being in consonance with geometry and physics and mechanics. We must see the true use or function of the jaw and the teeth, and the food destined for us, and how it should be comminuted; there is no chance-work about it! There is law and order pervading every part; the jaw forms a perfect triangle for the purpose of bringing into contact the largest amount of grinding surface of the bicuspids and molars, and at the same time to have the incisors all come into action during these lateral movements.

"You will also find that from the cuspids the bicuspids and molars run in nearly a straight line instead of a curved one back toward the condyloid process, enabling them to keep the largest amount of surface always presented for mastication. Another thing which has never been explained by anatomists or naturalists is the law of the normal relation of the upper to the lower incisors. The normal jaw should overjet and also have a corresponding underbite. Without such a law the incisors would lose largely their functions, that of incising on the principle of a pair of scissors. Where the incisors strike directly upon each other the power to cut off food is very much lessened. The length of bicuspids and molars proves the law.

"Another unobserved fact where law is expressed, where there is an overbite and underbite, just in proportion to their depth will be the length of the cusps of the cuspids, bicuspids, and molars. By drawing two lines from T to F, Fig. 853, or T to *a* and *e*, Fig. 847,

FIG. 847.



we have the lengths of the cusps of the bicuspids, *b*, in the upper and *c* in the lower, and also *d*, the second upper molar. The depth of the underbite is one-eighth of an inch from the cutting edge of the inferior central incisor *e* to that of the superior central incisor *a*. Did the teeth extend as far back as A, A, there would be flat surfaces at those points. But in articulating artificial teeth, when the superior second molar is reached, its distal cusp has to be raised from line T *e* to T *a*, Fig. 847, to allow the molar teeth on the opposite side, not in mastication, to touch; for merely balancing the plate, as Fig. 850, M, N, otherwise the second molars would be of no use in lateral movement, nor would the first molars. This curvature at the ramus (see Figs. 851 and 852) commences at the first molar, although it shows itself slightly in the bicuspids. Practically it need commence at the first upper molar. This curve, then, will always be proportioned by the underbite at *a*, *e*. The length of the cusps on bicuspids will never be more than an eighth of an inch normally; the groove deeper than that would cut the palatal cusp off and make of it a cuspid. It would in reality be cut in twain. *This is another unobserved fact. It always has been and will be found in the archtype of human jaws.* So that when you see a first superior bicuspid, it can very well be told from the length of the cusps whether the jaw from which it came had a depth of underbite of one-sixteenth of an inch or more. Where the teeth all strike fairly one upon the other and no overbite, then you have no occasion for cusps. If originally there they would soon be worn off from the abnormal articulation.

"This provision of articulation is most wise, carrying out still more fully the exact law by which the anatomical movements of the lower jaw for perfect mastication are governed. So beautiful and so mathematical a design cannot but call forth our admiration and wonder; and the study of no other part of the human body will give one a clearer idea of infinite wisdom. This movement we will find, in the artificial sets arranged upon this law, will prevent the plate from tilting. In the natural denture the incisors are really the first teeth to be arranged; though the first molars emerge first, to assist in the more perfect mastication of food and to keep the jaws at the proper distance. The incisors show a definite fixedness of purpose to arrange themselves after their typal shape, and to form the overjet and overbite at a given depth for the accommodation of the bicuspids and molars which are soon to appear, having cuspids of a definite length, so that the law of articulation which has been premeditated to a certain typal shape and construction, be carried out.

"It will also be found that the grinding surfaces of the bicuspids and molars have a typal shape—allowing them to meet with all their surfaces touching—for an express purpose, after a preordained and established law, from which the greatest area is gained for mastication; and that the inner cusps of the lower teeth are as necessary as the outer of the superior, when laterally moved. The law is still further carried out in the curvature at the ramus, from the second bicuspids to the third molar, to permit all the surfaces on one side to be in contact (Fig. 852), while the other unused side is only partially so (Fig. 851). The nearly straight line of arrangement from the cuspids to the last molar is also in keeping with the underbite (Fig. 847). It may well be asked just here: 'Will this law hold good in an artificial articulator such as I use, applied to setting of artificial teeth?' As soon as you once attempt to apply this principle you must certainly grasp this law, so wise and beautiful. There may be variations, but the general law will hold good, and where there has been much latitude or varying from it by abnormal mixtures of races or types, if Nature is given a fair chance to right herself, she will return to the normal standard of mathematical and mechanical precision; to do otherwise would annihilate creation. *Cells free to arrange themselves must develop the original creation, and perpetuate and keep it to the perfect standard by selecting the highest type of perfection in shape, strength, beauty, etc.*

"Could the reader but stand beside me while I arrange a set of teeth in this articulator, you must become converted to my system as founded on law and not on chance. There is no other part of the

human body that will permit of thus handling and unfolding, and again rearranging. No other that stands outside its own organic workings that will permit such demonstration. It is the key to the revelation of nature's inner workings, and unfolds, without a *missing link*, what we were, absolutely perfect in cell and organism for the inception, and simply in conformity to an infinite and all-wise law which cannot be blotted out. The teeth, individually, have been a great factor in science; and when they can be looked at from the point of view herein laid down and hitherto undeveloped, their significance will be magnified; and if we, as dentists, but take up the work as only belonging to our speciality and scientifically prosecute it, our honors and standing will be enhanced.

"Upon these bases I shall found the science of articulation, and apply it to the arrangement of all artificial substitutes, changing to suit individual peculiarities. The query here naturally arises to those who have never looked into the philosophy of this matter, whether these peculiarities are necessary, and if it is possible to utilize them in our artificial dentures; and, if so, how can it be done by any of the articulators now in the market, or can it be done at all by any human device? To all these inquiries I answer in the affirmative.

"As to the necessity, it should need no argument to convince you that an artificial denture should correspond to the natural one in every respect as nearly as can be approached. It may be a question with you how nearly art and mechanics can imitate the natural movements and expressions. Has there ever been any rule heretofore given by which you can regulate your beginning and ending with any kind of design? Have you any chart, system, or plan to go upon, such as the plot or sketches by which an architect, artist, or sculptor can bring forth his ideal? No! I say most emphatically. Look at all the sets of teeth made, I care not from whose hands they come, and you will not find one made after any special law to suit the individual case. Not that no sets have ever been made that have not been serviceable or look well, or where no taste has been manifested; I have seen many, but how much more useful and life-like they can be made by following the system as found in the natural jaw. I remarked it is so strange that these points should have been overlooked so long. To have examined the human jaw critically would have led to the plan at once. But we have acted on the principle that artificial teeth can only admit of the up and down or hinge-like movement. To allow of the lateral motion is thought to be impractical, as it would throw or upset them, and render them difficult to keep in place. The regular horse-shoe shape has been

adhered to up to the present, for fear that if the molars were placed outside the arch, the plate would tilt, and mastication be impossible. To give to the teeth the greatest advantage, you are taught by some to let the cutting edges of the incisors meet squarely, and have no overbite. If there has to be overbite, then the arch must be so large and wide, more than normal.

"It is taught that it is vandalism to grind the antagonizing surfaces of teeth, as if there was but one magnate to see them, the manufacturer of the teeth. You are also taught that but one side or cusp of the bicuspids and molars can be made to antagonize the outer. As I have studied the matter in its manifold bearings, and as my forte is in mechanics, I speak as having authority; and, if practice is of any value in establishing theory, I am prepared to give it to you in various ways, and attest that the adaptation of such work in the mouth holds good to the law as it does in this articulator I now present. So that when you have fitted in this device on the law laid down here, a set of teeth for any jaw, you can rely upon it, that if you had the jaw itself in your hands you could not approach more nearly to what is demanded. In some cases there is need of touching a cusp here and there, but to a very trifling amount.

"This triangle can only be found within a perfect circle in which you have the greatest breadth and area of surface. No other geometrical angle would have given such perfect beauty and symmetry to the face. The compactness brings the largest number of teeth nearest the centre of motion. The double joint permits the greatest strength and the easiest lateral movement with the greatest range of this at the least expense of power and compass. It permits the largest number of teeth to antagonize at every movement, *and, not least of all, this very triangle is the means by which nature develops the typal shape of the ramus, and of the formation of the jaws, the underbite, etc.*

"It will be observed that in making the lateral movement of the lower jaw to the left the condyle of the left side stands still or does not move backward, it merely revolves or rotates in the socket, which is but a trifle. The right condyle moves forward in the glenoid cavity fully half an inch, when at its farthest limit, causing the outer cusps of the upper, from the centrals to the last molar, to touch the outer and inner or buccal and lingual cusps of the lower on same side—the left (Fig. 852, and J K, Fig. 850); and on the opposite side (Fig. 851, and M, N, Fig. 850)—the right—we find only the inner cusps of the bicuspids and molars of the upper, to come in contact with the outer of the lower, and the centrals to

the cuspids do not touch. And why so little surface touching on right side when the lower jaw is thrown to the left? You cannot masticate on more than one side at once, and when you throw the jaw to the left in the act of masticating, the food is upon that side, hence there is no necessity for the right side to have so much surface in contact. But why should it touch at all on the right? In order that the muscles on both sides should act equally, which could not be done if the teeth were not allowed to strike there, giving support to that side of the jaw, and equalizing the force brought to bear upon that side, although no food be there. If there were no touching of the teeth on that side while mastication is going on upon the left side, there would result, as a sequence, that peculiar movement of the lower jaw at the condyloid process, which makes it difficult to place in teeth for the aged or those even in early life, who have lost all the grinders on one side.

"The form of triangle is necessary again for the purpose of giving the largest number of muscles a chance to act on both sides simultaneously and concentratedly, and thereby keeping the circle or arch of grinders down to their work, and equalizing the pressure on all sides. It enables the teeth on the side where the chewing is being done to arrange themselves when erupting, so that they will be very nearly in a line with the left condyle, which is now passive on this side, and forms one point of the dividers in forming the arc of a circle; and by this condyle being where it is—four inches from the other—the molars and bicuspids, as well as the central of that side, all come into the most perfect contact for chewing and incising, thereby carrying out this absolute natural law of the perfect adaptation of geometry and mechanics to her uses, and having no lost motion or function in any part.

"Again, the triangle gives us an extra motion forward, which brings the lower teeth in contact with the upper to incise or cut off food presented there. This could not have been with any other arrangement than the triangle. One central point at the pharynx or on the median line would have been a single swivel joint, and have brought the teeth across each other in such a way that as soon as any lateral movement commenced, they would be drawn away from each other very rapidly, and but little surface be in contact. This triangle will enable you to get just the exact depth of underbite from the incisors to the last molar, and the exact shape of arches; and particularly that of the ramus, which is not a matter of chance —neither is the length of cusps on the bicuspids and molars mere chance. The type has been preordained, just as the nose on your face, or the peculiar shape of the eye, or any other one part of the body.

And you will find that where a superior bicuspid has a cusp of a given length, the overbite will be governed and ruled by it. It cannot be otherwise. If in the arrangement of the teeth in the human jaw no type or design were laid down in conception or embryonic life, what malformed creatures we should be, mentally and physically! *And it will be found that just in proportion as there is congenital insanity, or want of will or directing power, there will be a malformation of the teeth and their arrangement.*

"The next step is, now that we know the exact shape of the jaw and its philosophy of form and functions, we must have at our command something so nearly approaching it that we can place our models upon it, and thus again restore nature's 'lost art.' I believe I have it here so nearly that it will be found to answer our most fastidious notions of setting by a system teeth on plate. The instrument is made of brass wire one-eighth of an inch in diameter (Fig. 846), and of such shape and movements as to correspond exactly with the mechanism of the human jaws. The base with its movements forms one part, and the two bows another. But one base is necessary for any number of cases. The bows which here are separated from the base can be duplicated to any extent. They are held firmly by thumb-screws, and after a case is once articulated to the bows they can be laid aside for future use. The lateral motion forbids the use of a prop to keep the bows apart. At first sight it would seem that the lower bow is moving in the wrong direction. Its motions are precise and correct. This has never been changed in design since first invented, in 1858. It permits of seeing whether the palatal and lingual cusps properly touch. In using it to get the lateral movement, one condyle must be kept close to the point where it is held by the spiral spring, while the opposite one moves forward. Never use both springs at once, except in bringing the lower jaw forward for incising. This method demonstrates that there is but one way to make a set of teeth articulate.

"Before placing the wax models in the articulator, it will not be out of place to say a word about this arrangement of the wax on the base plate and the selection of teeth in full sets. Always model the upper wax first, judging of the length of incisors by the trial of an artificial tooth in the mouth, such as, in shape, length, and width, would look natural and appropriate when held under the lip. This will enable you to get the height of wax and the contour after successful trial. The modeling of the wax on the upper plate is not arbitrary or fixed, so far as a definite law is concerned, in being able to work after a set pattern; here the true dental artist comes in. You get the length by trial of several blocks or single gum or

plain teeth, as may be, as well as shade of same. As to the arch of upper you must add to and take from, making depressions, etc., until your judgment tells you it is correct. To aid amazingly in this work of art, draw out the patient in a smile or broad convulsive laugh; compel him to do so; nothing tends so to relax most universally every muscle and give true expression to the countenance. If the wax is not in keeping with symmetry you will see where the trouble lies. Look at them in front and on either side when they are laughing, as a sculptor would upon his model. Be sure that the arch at the cuspids that form a double keystone to the arch stand out more prominently than any others. The superior first bicuspid should nearly always fall back somewhat behind the cuspids.

"Now that the upper wax is correct, the same rule applies to the lower. It is easy to make this conform to the upper; you may have to change the upper in some respects when tried with the lower, but not much. The length of wax at the molars may have to be trimmed to allow of equalizing the length of the teeth on upper and lower plates. Laughing and smiling will here again tell. Be sure to mark the centre at the median line, making marks or grooves through on either side, running from upper to lower for guide; they can be removed and are now ready for the articulator, with their bows pushed into their sockets in the base, which are retained by mere friction. The plaster models or casts with the wax articulation or bite thereon—and all fastened together by wax or cement to prevent being displaced from the cast—are now placed on this lower bow of the articulator, and the upper bow brought over upon the upper cast. Your eye soon detects whether the median line or wax is in the centre. To get the cast in proper place have a pair of calipers four inches between points, and by it place the cast in position, with centre of lower teeth just four inches from the condyles on either side. Hold in position, while with plaster you secure the upper to the bow, and when hard, the lower bow to the plaster cast in the same way.

"It may be asked where is the set screw to hold open the jaws of articulation after wax is taken off? I have never found it necessary in this kind of frame. Before taking off the wax, I take a pair of dividers, or a piece of wire bent with the points about one inch and a half apart, and mark, with one foot on plaster cast and the other at cutting edge of wax, the bite at the median line. Do this for both jaws. To secure this height for future repairs mark on each cast with the dividers the distance apart or width of dividers, and this will always be your guide for height. Take off all the

upper wax—except a section at the molars—first, and let the lower remain as a guide, for the arch of the upper. The first block or tooth fitted on the upper when backed with wax answers perfectly to keep the jaws of the articulator apart. The set screw would be in the way with the lateral movements. I stated that the length or depth of underbite in full sets is restricted to the width of the jaws and length of the centrals, which it is presumed have been selected to suit the individual case. Knowing how much the underbite is to be, you can very nearly guess how much to cut out the bicuspids and molars on all the grinding surfaces *before any of them are fastened to the base plate*, and how much arch upward at the ramus, from the second bicuspid backward and upward. If the underbite at the centrals is to be an eighth of an inch, then the bicuspids in the upper will have grooves between the cusps not quite so deep, and the molars still less. From the cuspids, then, the cusps are less to the second molar; were the incisors to strike equally and directly upon each other there could be no cusps or they would be of no use. The inner cusps of the upper should, as a general rule, be longer or higher than the outer. (See Figs. 848 and 850.) The outer cusp is more acute, the inner rounded. The lower the reverse—inner sharper and outer rounded, where the upper closes over the lower. For full sets you need but slight underbite, only enough to permit the lower to come forward and act as shears for cutting; at the same time it permits of cusps to both bicuspids and molars, and gives all double amount of grinding surface, there being cusps that touch on palatal and lingual sides, at same time as the buccal. Always bear in mind that the curvature upward at the ramus, of the upper set, is always in proportion to the underbite.

"If for an upper set alone you can tell how much the upper incisors should overbite by looking at the curvature of lower molar teeth remaining. If an eighth of an inch out of line the overbite should be fully so. This, when once understood, can give no trouble. The grooves in bicuspids and molars will form with the cusps, buccal and lingual, an ogee, as seen in Figs. 848 and 850, to give double the grinding surface when worked laterally; besides giving double cutting edges. All these grooves can be cut out before any are fastened with wax, so nearly that but little touching will be needed when the lower is articulated to upper. *The first bicuspid in the lower jaw should have but one cusp.* This perfect design will be seen in the articulator why it should have but one. Two would not only be in the way of the tongue, but be of no use. Be sure that the groove in the upper is made nearer the buccal side, and for the lower or lingual side for a reason which you will presently have explained, as seen in

Fig. 848. Now that the grooves are completed in the upper and all the teeth in place in the arch, we will articulate the teeth on the lower base. The height is soon ascertained by the dividers, and the central incisors tried on to see what changes will be needed. Fasten it temporarily with wax, and try it with the lateral motion and the points adjusted to meet all the surface on palatal side of upper teeth, when the lower is thrown to the side of the tooth being fitted. Cut from the cutting surfaces of each, whichever will make the most natural and strongest case. If for a very young subject, be careful; but for a middle-aged or elderly person do not scruple about the cutting edge and grinding surfaces, but sacrifice even the labial or palatal surface for the sake of effect and usefulness.

"I sometimes turn the buccal side of a molar inward to save substance and get effect and for better adjustment; frequently for want of room at ramus I do this; and, occasionally, turn buccal side upward for the grinding surface. If using blocks, before the front ones are fastened securely to the base plate, and while they are temporarily in their right place, try the bicuspid blocks to find out how much of the joint should come off of the incisors or the bicuspid block; or divide it. This will secure a better and more continuous joint and give the lower better chance to be arranged to the upper. Before

Fig. 848.

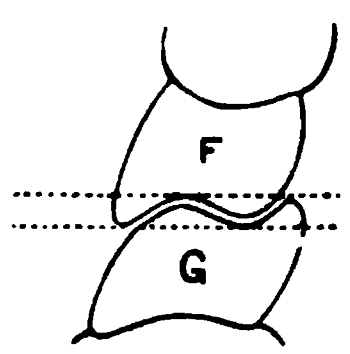
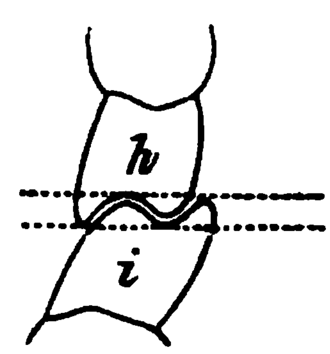


Fig. 849.

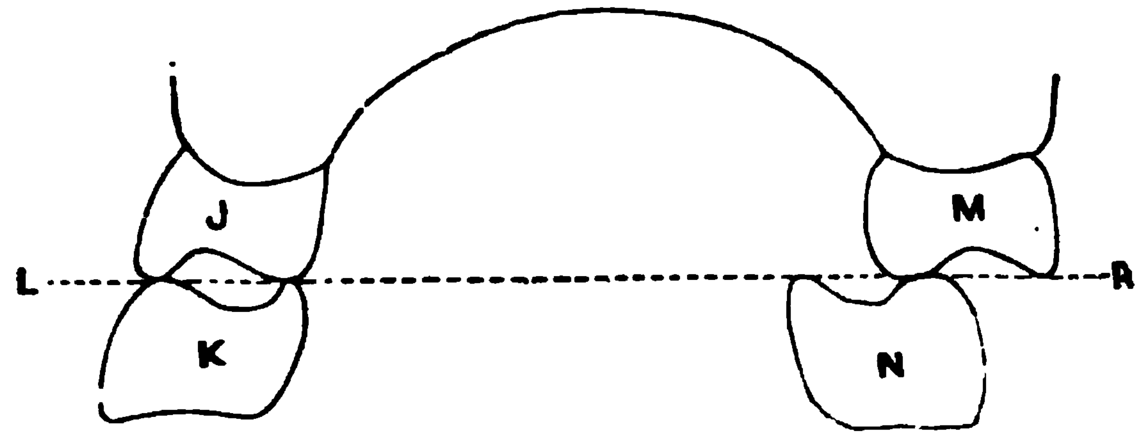


taking off too much of the joint of either of these blocks try the lower incisor and bicuspid block temporarily on wax, to know where the cusps are going to come. Regulate the joints by this. You can make the groove in the lower blocks the reverse of the upper, and cut them all out before much jointing is done, taking care that the groove is now on the lingual side and that the buccal cusps are rounded and the inner more acute, as in the buccal of the upper. *Never cut off any of the lingual cusps of the lower bicuspid and molar teeth,* such as are now made, as they are universally too short, and to get them long enough for service a large portion of the buccal cusps have to be cut down and rounded.

"The palatal cusps of the upper strike between the outer and inner of the lower (see Fig. 848) and, at the same time, these cusps should be long enough to allow in the lateral movement the incisors

and cuspid on that same side to touch simultaneously all the surface from the central to the last molar. If they do not, then your remedy is to make the groove deeper in both upper and lower, or perhaps the lower only, or the upper only (see J K, Fig. 850); ex-

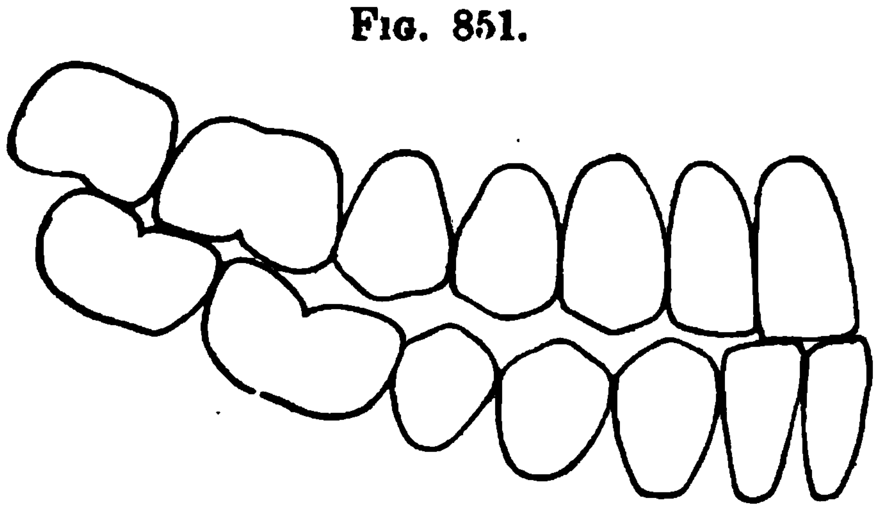
FIG. 850.



perience here will soon teach you which. When all the cusps are touching, inner and outer and the front one, take the opposite bicuspid and do likewise; and with the additional precaution, when the lower jaw of the articulator is turned to the left, to make the inner cusps of the upper strike the outer cusps of the lower (M N, Fig. 850) and *vice versa*, when thrown to the lateral right or left (J K, Fig. 850). The molars must have the same rule applied, with yet another additional point of great importance.

"The curvature of the ramus must be made to conform to the depth of overbite (see Figs. 851 and 852), so that when the lower

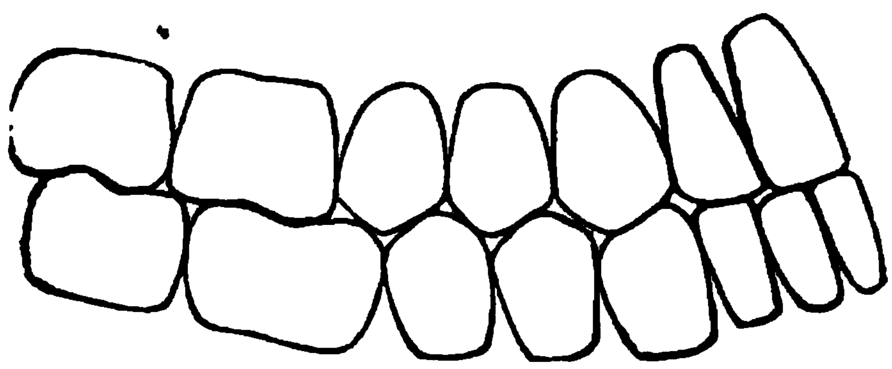
FIG. 851.



jaw is thrown to the right, the outer and inner cusps of both upper and lower sets on that side come together at the same time that the bicuspids and incisors do (see Fig. 852); but the curvature should be great enough to permit on the opposite side of the second molar tooth in the lower, which slides forward to meet the first molar in the upper, apparently moving backward (Fig. 851)—if they were on a plane, they would never touch, on account of the jaws opening as they move laterally to the right or left—to mount up on the cusps of the incisors an eighth of an inch, which would not allow the molars to touch, if on a straight line backward. But, inasmuch as

on the plane of grinding surface the first upper molar stands higher in the upper plane, the sliding forward of the lower jaw in the glenoid cavity brings the higher second molar in the lower in continuous contact with the first superior molar, as well as both outer

FIG. 852.



and inner cusps of bicuspids and molars of the upper and lower jaw (Fig. 851). This is specially done to equalize the pressure and force on both sides or parts of the dental arches. This permits of the most compensating arrangement of the teeth for equalizing the action of muscles on both sides simultaneously, and getting the greatest amount of grinding surface at each movement. This arrangement of bicuspids and molars is found in nearly all the lower animals; *the incisors, however, never touch when the jaws are in lateral movement.* Turn the lower jaw to either side and the effect is the same. *As I before said, but one side of the mouth can be used at the same instant, leaving the other free to balance the other side at work.*

"If the upper arch of incisors *of the natural teeth* should be broad or deep on account of the thickness of the base or body of the incisors, or where they are much inclined to protrude, then the arch at the ramus is not so great. In artificial sets this need never occur, carrying out the same rule in nearly every case, of controlling the curvature at the ramus by the depth of overbite and length of cusps of bicuspids. This system holds good in partial sets as well.

"This is all that is necessary to be said on articulation proper; it remains only to give a few points having a bearing on the perfection of the same. Select the broadest grinding surfaces to bicuspids and molars, that the bolus of food may be held securely on their faces, taxing less the muscles of the face engaged in mastication. Narrow surface would rather tend to cut the food than grind it. This is of no mean importance in rendering artificial teeth of greatest use.

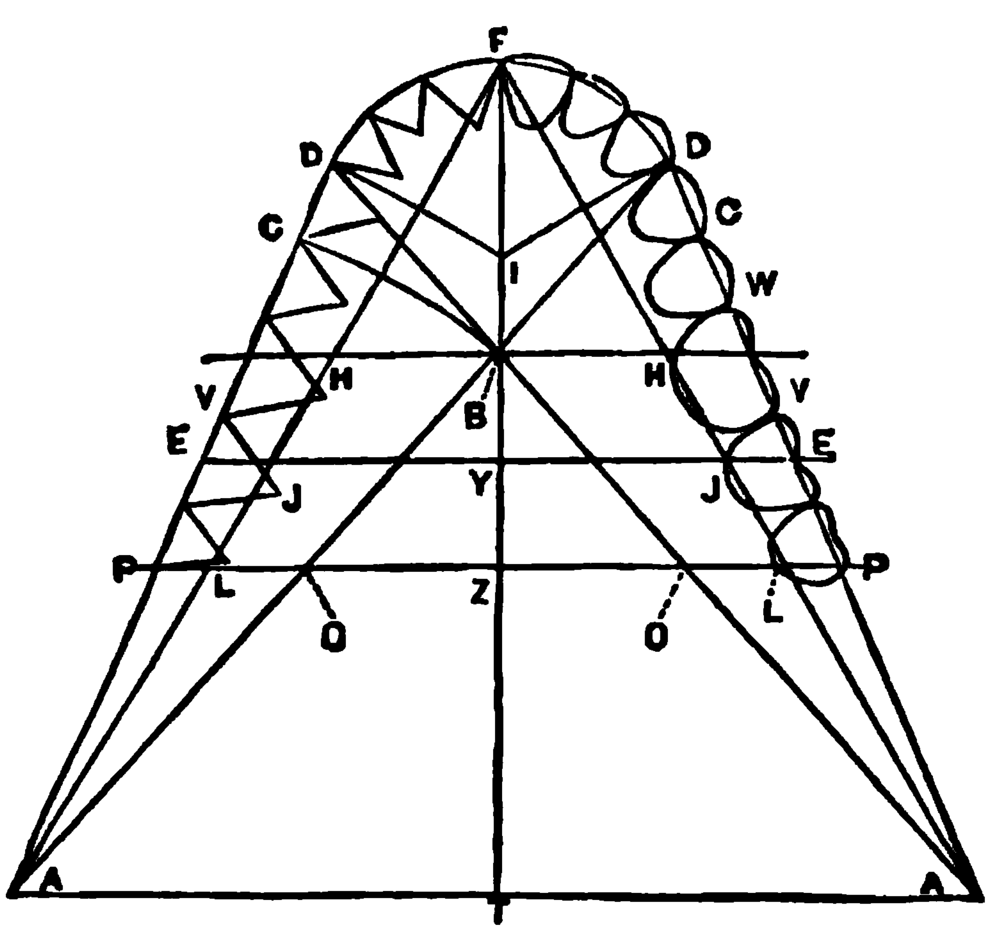
"To produce the most natural effect the centrals should be the lightest in color, and the cuspids a shade or so darker, with a difference in color of all the back teeth. I prefer on this account to set plain teeth wherever admissible—and nearly all lower cases are

so—and use different shades and arrange irregularly. The lower incisor teeth are mostly crowded, and I find to lap them over and distort them, even to a great extent, adds very greatly to their natural appearance. Don't be afraid of getting any case too irregular; very few natural sets can boast of perfect symmetry.

"After the teeth are fixed temporarily on the plate they should always be tried in the mouth to see if they are perfectly correct. As the mouth is more yielding in one part than another, the closing of the jaws rather firmly will allow of slight readjusting of themselves on the wax. If, when finished, they are found not to articulate properly—which is sometimes the case from the soldering or vulcanizing—have the patient bite on a strip of wax placed between the grinding surfaces to show the relation of each. Then put this back into the articulator and rearrange the grinding surface. It will be found to need but a trifling alteration.

"The false movement of the lower jaw at the condyles is found in nearly all persons who have had but one or two teeth remaining in the front arch, to reach which the jaw must be thrust forward

FIG. 853.



and laterally; and when artificial ones are placed in, the same old movements are continued until their attention is called to it. It can be corrected without any special arrangement other than following the law herein laid down.

"*The Equilateral Triangle within the Main Triangle.*—The outline drawings in Fig. 853 may be thought *ideal*. But any one at all acquainted with geometry, who has followed me in my argument and

description, must be struck with wonder at the marvelous ingenuity of the contrivance based alone on the equilateral triangle. It will be seen that perfection must be the result, since each part is complete within itself and the whole supporting each individual part.

"How have I arrived at this divination? The law is based upon the measurement of over two thousand human skulls. First, make an equilateral triangle, 4 inches each angle, A, A, F; draw a line from T to F. What is the guide to form the arch? Know the actual width of the superior central, lateral, and cuspid at their greatest diameter from the mesial to distal surfaces. say $\frac{18}{16}$, as in Fig. 848. Measure this off with the dividers, and place one arm at F and describe an arc from D to D through I. Then place dividers at I, and intersect the line just made from F, and it will be found that at D will be found the extremest point of the arch D, F, D, and will be the distal surface of the superior cuspid. Place the dividers at I, and describe the arc from D to D through F, which will constitute the normal and positive arch of the superior jaw. There will be an equilateral triangle from D, F, I on either side of the mesial line at F. The same will be found the base of each superior incisor.

"Next draw a line from A to D on either side, which will be the guide for the bicuspids and molars as to width and depth. Then, by placing the dividers at A and B, describe another arc to C, which will give the width of first superior bicuspid. The line from A to D passes through its palatal base, and will pass through centre of base of triangle of this tooth. Form another triangle by drawing a line from H to H, through B, which will pass through the centre of the first molar, and will give the width between the palatal surfaces, or their depth or thickness. Placing the dividers at I and F, we intersect the line from F to T at Y. Draw a line through Y to E, E, forming another equilateral triangle. From B to F is now the radius of another arc, which intersects the line from D to A at V, and the line A to D at O. A line now drawn E to E through Y intersects the centre of the second molar at E, E.

"Get half the distance between the points at E on the line from D to A, and the width of the first molar is made, and also the second, which is the angle of the equilateral of each. This leaves room between the first bicuspid and first molar, and is the width of second bicuspid; or it is shown by placing the dividers at A and Y, and intersecting line from D to A at W, same as from B to C, for the first bicuspid's width. The distance from D to D is the same as from D to the distal surface of the second molar. P to P through Z forms another equilateral triangle, giving the wisdom tooth's place in the arch.

"The arrangement of J and K (Fig. 852) on the left shows the teeth in the act of mastication, while on the right M and N (Fig. 851) the inner cusp of molars of the upper and outer of the lower molars come in contact when not in use. There is double the surface touching at every lateral movement. Fig. 851 shows right side, as at M and N, and Fig. 852 that of left side (J, K) in action from the mesial to the last molar. Fig. 848 shows both bicuspids and molars in normal relation."

The subject of articulation cannot be dismissed without a few words upon the great importance of extreme accuracy in all its details. It is a very remarkable fact that some of the most painstaking dental mechanicians practice methods of articulating in which there can be no certainty, and for constant errors in which the emery wheel is resorted to, in order to save them the mortification of making their work anew. In fact, there is no better evidence of the guesswork character of an immense number of articulations than the habitual attempts at correction by the equally guesswork shifting of movable articulators. We assert, without hesitation, that ANY articulation—whether with gold plate or with the temporary plates of vulcanite and other forms of plastic work—can be taken in such manner as not to require the slightest change in the relation of the articulating models. We shall not insult the profession by attempting to prove that, if it can be done, it should be done. Next in importance to accuracy of the impression is correctness of articulation. Defects in either are damaging to one's reputation. But there is this difference: that in the former the error may often be detected on trial of the plate, while in the latter case the finished work alone reveals the failure.

Defective articulation is a prolific source of the disgraceful shortcomings of VULCANITE DENTISTRY. By these terms we specialize that art and its accompanying science which begins with Hard Rubber and ends with a Vulcanizer; which knows nothing of the uses of gold save as a circulating medium, recognizing no quality in a dental material so highly as its cheapness, no merit in a process so valuable as its rapidity. So long as such principles rule in the dental laboratory, carelessness in articulation is of little consequence. But older practitioners, who are accustomed to handle the royal metal with a care worthy of its high character, will fully appreciate the great importance of a rigorously exact articulation.

Dr. W. Storer How* has described a method of utilizing plaster impressions for obtaining accurate antagonizing models as follows:—

* *Dental Cosmos*, September No., 1888.

"In the process of procuring counterparts of the jaws for which dental substitutes are to be constructed, every step should be taken with the greatest degree of exactness attainable, and accurate impressions are therefore essential as matrices in which the working models are to be cast. Impressions of edentulous jaws are commonly taken in mixed plaster, which is held in the bare tray, or in the wax impression previously taken in the tray. An elucidation of this part of the subject is not now entered upon, but it is assumed that in any case, whether the jaw be completely or partially toothless, an impression will be taken in plaster, and that, when practicable, the thinnest part of the body of the impression will be not less than the sixteenth of an inch thick. Fig. 854 exemplifies such an impression of a toothless upper jaw, and Fig. 855 in like manner

FIG. 854.

FIG. 855.

illustrates the plaster impression of an edentulous lower jaw. In both instances the trays are omitted from the cuts as not necessary to be shown.

"Plaster impressions are commonly varnished with an alcoholic solution of shellac or sandarach, and then oiled to insure the separation of the casts. The preferable way in most cases is to thoroughly brush the surface with a soft brush and strong soap-suds, and, after an interval of a few minutes to allow for absorption of the water of the suds, to fill the impression with a properly mixed batter of plaster.

"Several hours should preferably elapse before attempting to separate the cast from the impression, which should be preserved as nearly entire as possible, and when there is not much overhang the separation may by safely effected by progressive smart tappings with a light mallet over the whole surface of the impression. If, however, the labial portion must needs be first cracked off, this may be done, after cutting a groove in the impression as near along the crest line of the cast as may be guessed, using quick, light mallet-

blows to knock off the sections. These are to be carefully kept, and after the separation has been accomplished are to be replaced with the palatal portion on the cast and with a thin-mixed plaster built up to the approximate shape of an articulating model. When this has become quite hard it is removed from the cast, which, of course, it perfectly fits. It will also, if as an impression it was correctly taken, perfectly fit the jaw, and may therefore be placed in the mouth and judiciously trimmed until the proper expression has been produced, and the exact dimensions and contour of the desired denture embodied in this plaster articulating model. Such a model is shown in Fig. 856. In like manner one may prepare a similar model of the inferior jaw. Such rigid and exact-fitting models can obviously be replaced, trimmed, and readjusted in the mouth until the best skill of the dentist shall have been expended in obtaining models at once artistic and correct. The median-line mark is then

Fig. 857.

Fig. 856.

made with a pencil or knife, and cross-lines are made on the sides of both models while they are pressed together in the mouth, after many openings and shuttings of the jaws, to be sure that at last the proper relations of the models have been obtained. The occluding surfaces are then dried, warmed, some hot wax is dropped on them, the models are instantly replaced in the mouth, and the side-marks and median-line marks made to exactly coincide, while the models are pressed together by a firm closure of the jaws until the wax has quite stiffened. The joined models can then be taken from the mouth and replaced upon the casts. These are to be fixed with care in a suitable articulator, and the result will be a precise reproduction of the relative positions previously occupied by the models when placed on the natural jaws (see Fig. 857). Attention is here called to the fact that, normally, the horizontal line of occlusion is not straight, but curved so that the superior cuspids are at the bottom of the depression, as illustrated in the lines of the models,

Fig. 857. In the construction of models for full dentures it is important to maintain this curved line of occlusion for two reasons: First, the process of mastication is facilitated by the impingement of the lower bicuspids and molars, as these are occluded with their downward-graded antagonists by the antero-lateral movements of the lower jaw in the act of grinding the food ; second, the facial expression is improved by the rising of the respective planes of occlusion at those points, thus in some degree producing the effect that the limner accomplishes by upwardly-curved lines at the corners of the mouth.

"Fig. 858 also shows (though imperfectly) the correctness with which the plaster models may be made to anticipate the outlines of forms which the completed dentures are subsequently to assume in becoming both useful and beautifying works of art. The thin, sharp, in..exible borders of contact with the gum along lines which provide for a firm bearing of the model, and yet permit the free play of all the muscles concerned in acts of mastication and facial expression, are noticeable in Figs. 856 and 857 as being producible in plaster models. It is likewise observable in Fig. 857 that the normal overlap of the upper incisors upon the lower may be reproduced in plaster models and prove an important factor in sustaining the lips in proper profile relations,—a circumstance too often ignored or overlooked in the preparation of the ordinary wax models. These are, in fact, commonly so crudely and clumsily formed, and are withal so lacking in resistance to adverse impressions, that not only can no dependence be placed upon them as correct representatives of the relative parts previously studied and produced in the mouth, but from the very fact that wax forms are so easy of displacement and disfigurement, the steps in the process of obtaining such articulating models are hesitatingly and hastily taken, and of course result in faulty dentures, which, more than any other class of dental operations, proclaim the frequent failure of the dentist to so closely imitate nature as to conceal the fact that such an endeavor has been made. The practical permanence of the plaster model obviates all these defects, and, furthermore, admits of such a firm final closure of the jaws that, when at last the corresponding denture is placed in the mouth, both the occlusion and the articulation are found to be correct, as could never be the case after a timid trial closure upon a soft, slippery wax model.

"In Fig 857, as in the succeeding figures, the models and casts are to be viewed as mounted on articulating frames, which do not appear because not necessary for the purpose of illustration.

"Upon the removal of the models from the casts, after these have

been mounted on the articulator, both representatives of the edentulous jaws will appear as seen in Fig. 858, and in these cases the border outlines of the models are indicated to emphasize the need of making them conform to the muscle insertion lines whenever this is practicable; and that not only because of the increased stability of the dentures when they are free from liability to displacement by the lifting action of muscles improperly so covered, but also because the mobility of the adjacent features in the consequent naturalness of the facial expression will depend in great degree upon the judicious definition of the boundaries of the dentures.

"Fig. 859 shows the cast of the upper jaw in its relation to the articulating model in place on the cast of the lower jaw, and Fig. 860 likewise illustrates the cast of the lower jaw as related to the articulating model in position on the cast of the upper jaw.

FIG. 858. FIG. 859.

"A close observation and study of these illustrations will make clear the many points of advantage to be obtained by the employment of plaster in the construction, fashioning, and adjustment of prosthetic models for full dentures.

"Complete upper artificial dentures for use with more or less complete lower natural dentures constitute a large class of the cases coming within the province of the dentist, and for these the plaster articulating models are especially adapted.

"Such a model as that shown in Fig. 856 may be suitably shaped to articulate with the natural teeth of a lower jaw, as illustrated in Fig. 861, and in the process of shaping the plaster model great satisfaction will be derived from the security of the model's retention in the mouth, the firmness with which the lower teeth may be closed upon it, and the certainty with which, by frequent repetitions, a natural occlusion may be obtained. When this has been

done, and all the artistic conditions are complied with in perfecting the shape of the model, it is to be removed, warmed, and thus dried on its occluding surface, so that a roll of very soft impression-wax may be placed upon it and all be quickly replaced in the mouth.

"Repeated normal closures of the jaws are to be made, and the jaws then held tightly closed while the fingers of the operator are rapidly pressed upon the wax which covers the face of the teeth,

Fig. 860. Fig. 861.

so that on opening the jaws and carefully removing the model and wax there will be found an accurate impression of the teeth, which will have to pass through the wax to the model, pressing it firmly into its seat. The result is shown in the articulated model and cast. Fig. 862 shows the articulated casts when the model has been removed.

Fig. 862.

"If proper care has been taken in pursuing this process up to this point, the succeeding steps in the construction of a continuous gum, gold, celluloid, or vulcanite denture may be taken with complete confidence that the substitute, if made in strict conformity to the models, will exactly fit the maxilla, articulate with the natural teeth, and impart an appropriate expression to the related features of the patient.

"The foregoing method may in some cases be practiced when modeling composition has been used in taking the impression; or the composition may be employed in building the model upon the cast which has been made from a plaster impression. But for general use —and all the more so as the practice shall become familiar—plaster will be found most reliable and satisfactory as a material for both the impressions and the models."

CHAPTER XI.

PRINCIPLES AND APPLIANCES OF SOLDERING.

SOLDERING is the union of two metallic surfaces, either by slightly fusing the surfaces themselves (technically termed sweating, or autogenous soldering), as in the union of a plate of silver to a block of copper preparatory to rolling into Sheffield plate, or by the fusion of an alloy which melts more readily than the metals to be soldered.

The conditions of successful soldering, as given by the late Prof. Austen, are: 1. A freely flowing solder. 2. Absence of oxide from the surface over which the solder is to flow. 3. Proper amount and direction of heat in flowing the solder. The first condition requires good solder; of this we have elsewhere spoken. To limit the flow of the solder and protect all places which it should not encroach upon, a thin layer of plaster batter or a solution of whiting may be applied with a camel's-hair brush. The second calls for the use of borax, the specific action of which, as a flux, is—first, the removal of existing oxide by virtue of its powerful affinity for it; secondly, the prevention of further oxidation by the exclusion of the oxygen of the air. The third condition demands a skillful management of the blowpipe flame; this is the principal difficulty with most beginners and, indeed, with not a few old practitioners.

The borax should be used in the lump and rubbed with pure (distilled or rain) water upon a coarsely-ground *glass* slab until a creamy paste is formed. Into this the pieces of solder may be placed, and also some of it applied with a small brush or feather to the surfaces over which the solder is required to flow. Hard water and the common practice of rubbing borax on a slate make it impure and to some extent interfere with soldering. Too much borax is objectionable, and gold requires less than silver. The solder is placed along the

base of the backing, and if this is short the solder can be directed in its flow by the flame of the blowpipe to the holes of the pins; if the backings are long it may be best to place a small piece of solder over the holes of the pins in addition to the piece along the base of the backing. The solder should be tested before using by melting it on a piece of silver plate.

In fulfilling the third condition—the management of the heat—the following points demand attention: (*a*) To raise the heat very gradually, until the water of crystallization of the borax is slowly driven off; for if this is done rapidly the borax puffs up and throws off the solder; rapid heating at the outset is apt also to crack the teeth. (*b*) To diffuse the heat when using the blowpipe, so that the solder shall not become melted before the metallic surfaces are hot enough to unite with it, else it will roll into a ball or flow with an abruptly-defined edge; whereas it should unite so smoothly with the plate that, except for the difference in color, its line of termination cannot be detected. (*c*) To manage the fine point of the blowpipe flame so as to be able to direct the flow of the solder to any given point; the rule being that, unless prevented, solder will flow toward the hottest point. There are two kinds of flame given by the blast of the blowpipe: 1. The broad, heating-up, or oxidizing flame; this is produced by holding the tip a little behind or at the edge of the flame. 2. The pointed, soldering, or deoxidizing flame; this is produced by passing the tip more or less into the flame. A very general mistake is to use too strong a blast.

The apparatus required for soldering includes a lamp to give a sufficiently hot flame; a blowpipe to give intensity and direction to the flame; borax, brush, glass, slate, solder, and solder-tongs; investing materials and clamps to protect the teeth, also to hold the parts in relation to each other until soldered; a receptacle to retain or give additional heat during the process of soldering; an acid (sulphuric) bath, to remove the glass of borax.

As accidents sometimes occur from the flame communicating with the explosive mixture of air and alcoholic vapor in the body of the lamp, it is prudent to make a *safety lamp* by connecting the wick tube with the body of the lamp by a small tube which shall be, under all circumstances, full of alcohol. Figs. 863 and 864 represent such lamps. If the wick is not permitted to run below the shoulder above the horizontal tube this tube will remain always filled with alcohol. The top of the wick tube should be beveled off in a direction just the reverse of that shown in the drawing, so as to permit the downward projection of the flame. Fig. 865 is a very ingenious modification of the safety lamp, made by Dr. B. W.

Franklin, so constructed as to retain the alcohol uniformly at the same level.

FIG. 863.

The fluid used in these lamps is usually alcohol. For all purposes of dental soldering alcohol gives a sufficient degree of heat, and is

FIG. 864. FIG. 865.

much more cleanly than the carboniferous flame of ethereal oil, sperm oil, coal oil, or gas.

To give intensity and proper direction to the heat of the lamp, a blowpipe is necessary. The simplest is a tapering tube, fifteen to

FIG. 866.

eighteen inches long, and curved at the smaller end (Fig. 866). At this end the bore for the last half-inch should be *perfectly* cylindrical and about as large as a medium-sized knitting needle. This may be modified in several ways and made more useful. First, by

cutting it within three inches of the flame end and inserting a small, hollow ball or cylinder, to receive the condensed moisture, which, in the plain blowpipe, often interrupts the blast. Secondly, by attaching a flattened mouth-piece, which is much less fatiguing to the lips to grasp. Thirdly, by connecting the flame end to the mouth-piece by from six to twelve inches of flexible tubing. The flame end ought to be straight, and from four to six inches long; a cigar holder makes an excellent mouth-piece. A bulb or enlargement in the tube might be serviceable in retaining condensed moisture; but it is less liable to accumulate in rubber tubing than in the metal pipes. There are many forms of mouth blowpipes, and some quite expensive ones; but the pipe with flexible tube, as here described, will be found very convenient for the laboratory.

FIG. 867.

FIG. 868.

FIG. 869.

Figs. 867, 868, and 869 represent different forms of blowpipes devised for the purpose of preventing the moisture which accumulates within the tube from being blown from the orifice and interrupting the blast.

Figs. 868 and 869 are modifications introduced by Mr. Thomas Fletcher, and for the latter it is claimed that the mouth-piece is the easiest to use, and the heaviest continued blowing causes no strain

on the lips, while the tongue has the necessary control over the opening. Being held as a pencil, the chamber on the stem stops all condensed moisture and prevents the heat ascending to the end.

The mouth blowpipe requires in its use a peculiar management of the muscles of the chest, cheeks, and palate, by virtue of which an uninterrupted and regular current of air is thrown from the lungs through the pipe. The simplest way to learn how to do this is to first practice blowing exclusively during *inspiration*; this calls into action the cheek muscles and involuntarily closes the opening between mouth and fauces. Then use the pipe solely during *expiration*; this teaches control of the chest muscles in the emission of a steady, gentle blast. The art of using the blowpipe without fatigue consists in alternating the action of these two sets of muscles; the art of giving a perfectly steady, uninterrupted blast implies control over these muscles and the ability to pass from one set to the other at the moment of opening or closing the entrance to the

Fig 870.

fauces. After persevering practice of the two methods of blowing, the art of connecting them will come almost unconsciously; when once learned it is never forgotten. Those who are too indolent to master the first difficulty of learning it become the slaves to mechanical appliances which, however useful for many purposes, can never supply the place of this simplest and best of all blowpipes.

Blowpipes working by artificial blast may be divided into four classes: 1. Alcoholic or self-acting blowpipes; 2. Mechanical or bellows blowpipes; 3. Hydrostatic blowpipes; 4. Oxy-hydrogen or aëro-hydrogen blowpipes. Of each of these we shall give an example. To enumerate all the forms that inventive talent has devised would fill too much of our space.

The SELF-ACTING blowpipes derive the force of their blast from the vapor of hot alcohol, which, igniting as it passes through the flame, adds to the intensity of the heat. A somewhat complex but very complete blowpipe of this class, invented by Dr. Jahial Parmly, is shown in Fig. 870.

The lamp, G, supplied from the reservoir, D D, heats the alcohol in globe, I, supplied from the reservoir, J, through the pipe, H. The elastic vapor escapes at the jet, F, giving intensity to the large flame, L, which receives its supply of alcohol from reservoir, M J. Both upper and lower wick tubes have movable cylinders for regulating the flame. A small charcoal furnace, K, may be brought in range of the flame for melting purposes.

Smaller and more portable lamps are made, of which quite a number of different patterns are to be found in the depots. The

FIG. 871.

FIG. 872.

principle and general plan of construction are very clearly shown in Fig. 871, designed by Dr. S. S. White. All alcoholic blowpipes give intensity of heat, but are greatly inferior to the mouth blowpipe in the control which the operator has over the force and direction of the jet.

The different forms of the MECHANICAL blowpipe are almost infinite. The principle of construction is either that of the bellows

or the force pump, combined with a reservoir of air to give uniformity to the blast, which would otherwise issue in jets.

FIG. 873.

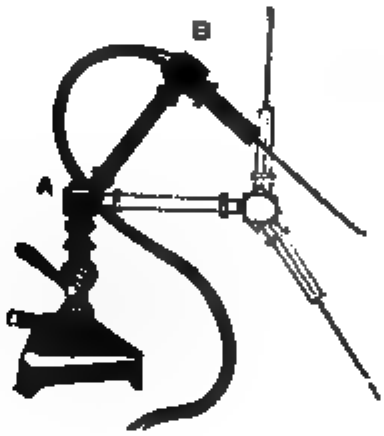


FIG. 874.

A common house bellows secured to the floor will form a simple and good arrangement. A spring should separate the handles, the upper one of which forms a treadle. An india-rubber pipe should pass from the nozzle to an air-tight box, from which a second tube comes out and is attached to the blowpipe. If the bellows is made double, like a blacksmith's, the upper half forms the air-chamber in place of the air-tight box.

Fig. 872 represents the Burgess blowpipe, which is a convenient and efficient form. A is the cylinder of the pump, which is 2½

FIG. 875.

FIG. 876.

inches in diameter, allowing a 3-inch stroke. B, piston rod. C is heel-and-toe treadle for driving the pump. D, the receiver, 12 inches

high by 3 inches in diameter, into which the air is forced. The whole height of the machine is 24 inches; the base is 12 inches by 5.

Figs. 873 and 874 represent Fletcher's bellows blowpipes, capable of being adjusted in any desired position.

Figs. 875 and 876 represent two forms of the Fletcher automatic blowpipe, one of which is mounted on a ball-joint. These forms are very convenient for soldering, especially in the manufacture of gold crowns and bridge-work.

Fig. 877.

Fig. 877 represents a style of foot bellows by which the bellows and automatic blowpipes are operated. Fig. 878 represents a carbon block for use as a support in soldering. It is a perfect non-conductor and much cleaner than charcoal. Fig. 879 represents a carbon

Fig. 878.

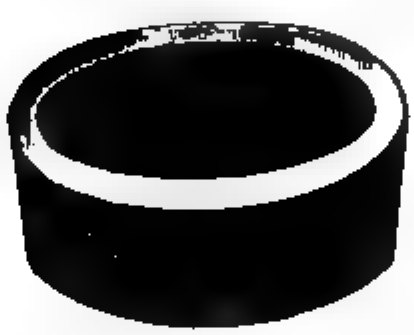


Fig. 879.

Fig. 880.

cylinder, the cupped end of which answers as a good support for small cases, such as crowns, while soldering.

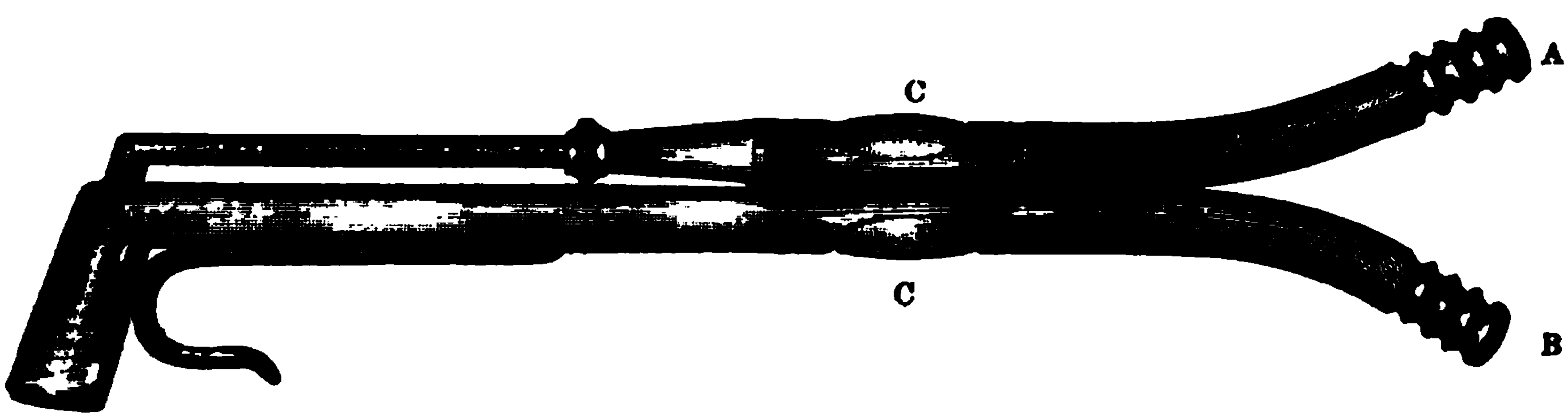
Fig. 880 represents Macomber's gas blowpipe. The direction of

the point, 1, is regulated by the joint, 3, and the supply of gas controlled by the stopcock, 2. The air is supplied from the lungs, or from some form of mechanical or hydrostatic blowpipe, through the flexible tube.

Fig. 881 represents a hand blowpipe, into which the air is admitted at A and conducted through a small tube to the upper end of the gas-pipe, B. The supply of both gas and air is regulated by pressure of the thumb or fingers on the rubber tubes, C, C.

The THIRD class of blowpipes is sometimes combined with the second to regulate the blast, or with the first to intensify it. In its uncombined form it consists essentially of a blowpipe point attached by a flexible tube to an air-chamber, from which the air is forced by the steady pressure of water. When once set in operation, it is

FIG. 881.



self-acting, and in this respect has great advantage over the second class. This, with the perfect regularity of the blast, makes a properly constructed hydrostatic blowpipe much the best of all substitutes for the lungs and mouth blowpipe.

The gasometer of the nitrous oxide gas apparatus makes a very excellent hydrostatic blowpipe. Its form, and the manner of using it, are so familiar to dentists as to render any illustration or description unnecessary. Any required force of blast may be given by detaching the counterpoise, or by adding weights to the descending cylinder.

Prof. Austen gives the following description of a simple and inexpensive apparatus suitable for laboratories where no pressure can be had, as in cities, from public water-works. "Place in a convenient position a strong 10 gallon water-tight oak cask, two feet from the floor. Over this, and two feet above it, place a second of the same size, with a movable cover, so that water may be conveniently poured into it. Connect the casks by a tube running nearly to the bottom of the lower cask, and having a stopcock, *a*, between the casks. Into the top of the lower cask insert a stop-

cock, *b*, to which attach the blowpipe tube, and into the bottom a larger stopcock, *c*, for drawing off the water. It is prepared for operation thus: close all the stopcocks, and fill the upper cask to within an inch of the top (if too full, it might chance to overflow the lower cask and force water out of the blowpipe upon the flame and work); then open the stopcocks, *a*, *b*, and the jet will issue with a force proportioned to the height of the water. If too strong, it may be regulated by pressure upon the elastic tube or by partly closing the stopcock. Ten gallons of air will suffice for any ordinary case of soldering; but the process is easily renewed by closing stop *a* and drawing off the water, by stop *c*, from the lower cask, and emptying into the upper. This can be more rapidly done if stop *b* is left open, so as to admit air freely while drawing off the water."

FIG. 882.

Another, but more expensive form, is shown in Fig. 882, made of copper or boiler iron, and connected by lead pipes with the public water-works in towns and cities thus supplied. The drawing, taken in connection with the previous description, makes any explanation unnecessary.

The fourth class of blowpipes is analogous in its operation to the oxy-hydrogen blowpipe. The point is double, consisting of a tube, through which comes the supporter of combustion (oxygen or common air), surrounded by a cylinder, through which comes the combustible (alcoholic vapor, illuminating gas, or hydrogen). In Count Richmont's aëro-hydrogen blowpipe the hydrogen is generated in a vessel by the action of dilute sulphuric acid upon zinc, and the air forced through the centre tube, either with a bellows or from the lungs. The heat is less intense than that of the oxy-hydrogen blowpipe, but is too great for most laboratory purposes. The gas blowpipe is a very convenient instrument; the principle is similar and the heat very great.

Fig. 833 represents an ingenious oxy-hydrogen blowpipe invented by Dr. J. Rollo Knapp, which consists of an iron stand in which is secured, by a thumb-screw, a 100-gallon cylinder of nitrous oxide gas. By means of a yoke and set-screw the valve of the cylinder is connected with the tubes and valves of the blowpipe in such

manner that the proportions of the mixture of nitrous oxide and illuminating gases are under perfect regulation and control.

There are two pipe-nozzles, which may be used at the same time, or one at a time, according as a large or small flame may be desired. One pipe-nozzle is shown as hung upon its hook, and the other as

Fig. 882.

if directed upon work held on the pivoted bracket-table. It can be used wherever illuminating gas is available. Any of the soldering operations of the laboratory, from the largest piece of crown-work to the most delicate joining of the narrowest bands or finest wires, are accomplished with equal facility. With illuminating gas of good quality and sufficient pressure a pennyweight of 20-carat gold can be

melted in thirty seconds. A large investment must be heated first by other means.

The apparatus consists of the blowpipe attachments, connected to the yoke of a nitrous oxide gas-cylinder, the cylinder being set upright, and secured by a thumb-screw on one end of an iron base or stand, at the other end of which is pivoted a table upon which to rest the work. The blowpipe proper is a continuation of the outlet-tube of the gas-cylinder. A lever-valve, G, regulates the supply of nitrous oxide. Just beyond this valve is the mixing-chamber, K, to which the illuminating gas is conducted from the gas-bracket by means of rubber tubing, entering the bottom of the chamber through the valved tube, C. The lever, D, controls the supply. The mixing-chamber is provided with a gauze screen to prevent the flame from being drawn into the supply-tubes. Immediately beyond the mixing-chamber the pipe is branched to afford two flames of different sizes, E and F, which can be used independently of each other or both together. The valve-lever, L, regulates the flame in both. For greater convenience in manipulation the pipe-nozzles are connected with the branched pipe by rubber tubing. From the body of the valves, L, an arm extends, at the end of which is a small scalloped disk as a holder for the flame-nozzles when not in use. In the illustration one of the nozzles is shown in the holder, the other being directed to the revolving table.

In the operation of soldering the parts to be united must be held together in their exact relative positions. This can sometimes be done by simply laying them together; but usually they must be held in place, either by iron wire bound around them, or by small clamps of iron wire, or by rivets; or else by some investing material, which, in dentistry, is always plaster mixed with some substances that will counteract its tendency to shrink and crack under soldering heat. This substance may be coal ashes, soapstone dust, feldspar, clean sand, or asbestos. The two latter are the best, and may be mixed in proportions varying from 2 to 6 parts sand or asbestos to 4 of plaster. As a rule, the less plaster, the less shrinkage; but a very small quantity makes the investment too friable.

A common mistake is to use too large a quantity of investing material. This almost invariably results in the warping of the plate; for, as all investments have some degree of permanent contraction, and all metals must expand, if the latter is bound by a rigid, unyielding mass it will inevitably warp. Hence, as a rule, use no more investing material than is necessary to keep the parts to be soldered in their position and to protect the porcelain surfaces

from direct contact with the flame. This subject will be further considered when speaking of the soldering of teeth to the plate.

In selecting a suitable receptacle for the work to be soldered, it is important to retain the heat, especially when using the mouth blowpipe. A funnel-shaped mat made with scraps of woven iron wire, or a large lump of pumice stone, or one of close-grained charcoal, with the outside coated over with a thin layer of plaster, form very simple and convenient receptacles for smaller pieces of work. For larger work, or for very high temperatures, it is important to receive additional heat from ignited charcoal, for which purpose the soldering pan (Fig. 884) is a very admirable contrivance. The movable lid remains during the heating up and the cooling off, but is, of course, removed during the act of soldering.

Fig. 884.

Fig. 885 represents the form of soldering blocks which are made of either plumbago or asbestos.

After soldering the work should cool gradually, unless it is to be re-swaged. If there is any porcelain attached the cooling must be very gradual. When cold, it may be placed in dilute sulphuric acid and slowly raised to the boiling point, kept there for a few moments, and then slowly cooled. This dissolves the glass of borax, which is so hard that it injures the edge of files and scrapers.

A few general considerations may be of service in the use of the above-described appliances for soldering. It is an operation regarded by many as attended with much risk; and by students generally it is

considered the *pons asinorum* of dentistry. Whereas, there is no process in dental prosthesis in which the desired result can be with more certainty obtained, provided such care and skill are exercised as alone can give success in any department of the art.

Plates warp from want of support when heated or from excess of investing batter; they are burnt, blistered, or melted from careless or ignorant use of the blowpipe. Teeth are broken from rapid heating or cooling; they are displaced by the shrinking of an ill-judged investment. Solder is condemned because it will not bridge a chasm one-eighth of an inch wide, will not run over plaster, will not attach itself to an oxidized surface, or will obstinately roll up into a ball rather than flow over a surface too cold to receive it. These and all other vexations of soldering are the result of haste, ignorance, or want of skill. If there should be spaces under the teeth or backings, which, however, should always be avoided if possible by adapting the teeth in grinding to the surface of the plate and having the backings of a proper length, such spaces should be

FIG. 885.

filled with gold foil. As much of the surface of the plate should be exposed as can be done by trimming away the plaster without affecting the stability and safety of the teeth, so that no obstruction is present to the flame of the blowpipe; this direction is especially applicable to a lower denture either full or partial. Good soldering depends upon the perfect heating up of the investment and plate, so that the solder can be brought by the heat of the blowpipe flame as near the melting point of the plate as possible without injury to the latter.

In soldering two surfaces, as in the doubling of lower or shallow upper plates, the borax must contain no particles preventing contact of the plates; also the heat must be directed on the side opposite the pieces of solder, so that when melted it may flow be-

tween the plates from one side to the other. Clamps are preferable to plaster batter for holding parts together, whenever practicable, as in soldering a wire or band around plates; but when the relation must be preserved with utmost accuracy, as in clasps, the plaster investment is essential. It is also necessary for the protection of porcelain from the direct action of flame.

In soldering teeth to a plate the batter must have such proportion of plaster with asbestos or sand as to admit of being used in small quantity, and yet be so strong when heated that it will not crack and endanger the position of the teeth. Backings and clasps must fit accurately wherever they are to be fastened. There should be no trace of plaster on a surface where solder is to flow; or, in fact, substances of any kind except borax, and not too much of that. Borax must be pure and clean, and used with soft water, and the heating must be gradual, in view of its liability to throw off the solder. Solder must be of good quality and carefully placed, never putting two pieces where the position will allow the proper quantity to lie in one piece. It is a very common practice to cut solder into very small pieces under the idea that it will flow more evenly; but if a plate is properly heated and the blowpipe flame skillfully managed the large pieces melt instantly and flow into their proper position.

It is quite possible, by careful observance of these directions and by expertness in the management of the blowpipe, to solder any set of teeth so that there shall be no roughness or abrupt edges requiring the use of files and scrapers. In fact, these tools are never needed to give finish to a perfectly soldered joint; the natural flow of the solder takes a shape which cannot be improved.

CHAPTER XII.

ADJUSTMENT OF PORCELAIN TEETH TO THE PLATE—FINISHING PROCESS.

WHERE vacancies between natural teeth are to be filled it is highly important that the artificial teeth should correspond in shade and color with the natural organs; for in proportion as they are whiter or darker, will the contrast be striking and their artificial character apparent. Of the two faults it is better that they should be a little darker than any whiter. They should also resemble in shape those which have been lost, so far as it is pos-

sible to ascertain this. Minute accuracy as to shades of color involves the necessity of a large assortment, unless one is located near a depot or agency. But the facilities of mail and express greatly lessen this necessity, provided there is time to send for the tooth or teeth required. It is desirable, in view of this method of matching shades of color, to keep all refuse or broken teeth to be used as samples in sending orders.

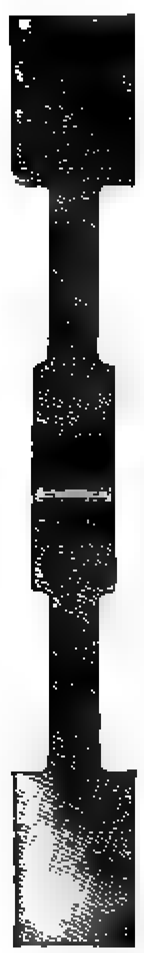
The manufacturer supplies three varieties of plate teeth—plain, gum, and sections. The latter have the advantage of showing few joints, but are less easily repaired and are not applicable to so wide a range of cases. Gum teeth or sections are applicable only where there has been sufficient absorption to permit the extra fullness of the artificial gum. Many mouths are deformed by a foolish craving on the part of the patient, which the dentist is equally foolish in yielding to whenever plain teeth are more appropriate. In point of strength, durability, and facility of repair, plain teeth are superior to the others; they are also more readily adapted to the plate.

The manufacture of gum teeth in sections of two, three, or four teeth has been brought to such perfection that comparatively few single gum teeth are now used; especially since new methods of attaching these sections to the plate have rendered unnecessary that exact fitting of blocks which was one objection to their use. This perfection of manufacture has also done away with the necessity, on the part of the dentist, of devoting to the making of block teeth the very large proportion of his time formerly demanded by this difficult process. Whenever special cases demand blocks or sections made to order, it will be found more satisfactory to send proper models and descriptions, and have such teeth made by those who are thus constantly occupied, than to incur the disappointments and delays inevitably attendant upon infrequent and irregular attempts at block work.

For the proper shaping of models or articulators to accompany such orders directions will hereafter be given. These blocks, when received, do not need much, if any, grinding. But all plain teeth, single gum teeth, and ordinary sections or block teeth require, after selection, to be more or less accurately fitted to the base plate. For this purpose they must be ground on emery or corundum wheels until accurately fitted, and must be so arranged, in full cases, as to meet the teeth with which they are intended to antagonize at the same instant around the entire arch; in partial cases the natural teeth should touch their antagonists more decidedly than the artificial ones. A correct articulation will enable the dentist to antagonize the teeth with perfect accuracy.

The movements of the tongue, lips, and cheeks must be considered in the adjustment of artificial teeth, and the expression must be carefully studied; hence some general rules may prove serviceable. The median line of the face should exactly come between the upper and lower central incisors; the centrals and laterals on each side should lean slightly toward the median line, the laterals a little more so in most cases than the centrals, the cuspids very slightly, and the bicuspids and molars almost perpendicular. In a full denture the anterior teeth should lap but slightly, only enough to

FIG. 886.



permit the cutting edges of the upper front teeth to pass over those of the lower teeth; the six anterior teeth, therefore, should not meet, but the pressure should be upon the bicuspids and molars, and be equal on both sides. Lisping is prevented by having the front teeth lap but slightly, and the stability of the denture is increased. The articulating model will govern the length of the teeth, especially the anterior ones. The arrangement of the posterior teeth should correspond to that of nature, the articulating surfaces of the inferior second bicuspids and first molars curving downward, so that the second bicuspids and first molars are somewhat shorter than the first bicuspids and second molars; by such an arrangement the denture is less liable to be forced forward in mastication.

For proper expression the anterior lower teeth should occupy a perpendicular position, as it is seldom necessary to incline them outward or inward. Even when the lower jaw projects somewhat the lower teeth should be perpendicular and the upper teeth incline or project out to meet them. Fullness of the gum under the nose should be avoided, as the lip is given an unnatural fullness by such a thickness of material. It is frequently necessary to make considerable fullness of the gums of the cuspid teeth.

There should be an outward curve of both upper and lower teeth when the face is observed in profile.

In arranging an entire set for the upper or for both jaws the molars should be so adjusted that the inner or palatine tubercles come together as well as the outer ones. This precaution is necessary in antagonizing single as well as block teeth. If the outer tubercles strike first the pressure there will spring and loosen the plate. For the same reason upper molars and bicuspids should not be set so that the force of mastication falls outside of the ridge. The inferior teeth should be placed well on the alveolar ridge, and not inclined inward or too much outward, and sufficient space be allowed for the movements of the tongue.

The lower teeth of an entire denture may with advantage be longer than the upper teeth, and thus insure greater stability; hence the lower front teeth (incisors) should be arranged first, then the upper teeth of same class, and the same rule followed in regard to the remaining teeth. An unnatural regularity in the arrangement of artificial teeth should be avoided, as a slight irregularity will often harmonize with the features. The first bicuspids of the upper jaw should articulate between the first and second bicuspids of the lower jaw, so that each tooth meets two opposing teeth. The upper first bicuspids should be partially hidden by the cuspids when the denture is in the mouth, and the upper bicuspids and molars should project slightly over the corresponding teeth in the lower jaw.

Placing artificial teeth outside the ridge is often a cause of failure in securing serviceable dentures. The curve of the arch in both jaws should be made by the six anterior teeth, and by these alone. The prominence of the cusps of the posterior teeth should be preserved; hence the necessity for careful articulation, that it may not be necessary, after the denture is completed, to grind off the masticating surfaces of such teeth. The greatest pressure of mastication should be upon the second bicuspids and first molars; hence the second molars may be arranged so that they are somewhat shorter than the teeth referred to.

In partial upper dentures supplying the first and second molars, and in some cases also the bicuspids, on both sides, should a natural inferior molar remaining in the mouth have an inclination forward, as is generally the case when the teeth in front of it are wanting,

FIG. 887.

FIG. 889.

FIG. 888.

such a tooth should be avoided in the articulation; otherwise, the denture is liable to be forced forward by the pressure of such a natural tooth against the teeth on the denture, as such pressure increases as the jaws are closed together.

A small space should be left between the last tooth of the upper and of the lower jaw in those cases where the crown of the lower molar looks forward, its posterior edge being a little higher than the anterior.

It is often necessary to cut away a considerable portion of a tooth in order to make it fit accurately to the plate. This makes the process of grinding very tedious, unless the operator has a number of sharp-cutting corundum wheels varying from half an inch to three or four inches in diameter.

Fig. 886 represents an excellent form of corundum wheel (the suggestion of Dr. S. Lee) for jointing porcelain gum teeth, and is made of various grits.

These wheels may be attached to a hand lathe, such as represented by Fig. 887 (Coy's noiseless hand lathe). The foot lathe is, however, far more convenient for laboratory use, where much grinding is to be done. Of these the depots furnish some excellent varieties. Figs. 888 and 889 represent the Snowden & Cowman

Fig. 890.

and the S. S. White, which are admirable lathes for dental purposes, while in Fig. 890 we have the Amateur lathe, which is a larger, stronger, and more powerful lathe, capable of very rapid motion; also adapted to the making of small instruments, handles, etc.

The lathe of Dr. Lawrence, with detached driving wheel and head that can be attached to any convenient board, shelf, or table (Fig. 891), has advantages that will make it very desirable to many.

Wheels may either be set at intervals on a long spindle, or screwed singly on the end of the mandrel (Fig. 891). In the latter

case they should be fixed with a screw chuck in the centre, so as to be quickly changed from coarse to fine or from large to small. In grinding the wheel should revolve toward the operator and be kept constantly wet with a sponge held either in a sponge-holder or between the ring finger and little finger of the left hand.

Fig. 891.

The thumb and forefinger of each hand must be free to hold the tooth, the right wrist being steadily supported on the hand rest (Fig. 892). Two faults are very common in grinding: one is, revolving

Fig. 892.

the wheel too rapidly; the other, bearing the tooth too heavily against the wheel. The first hinders rather than helps grinding;

the second is very apt to throw the tooth from the fingers and destroy the delicacy of touch necessary for accurate grinding.

Fig. 893 represents the cone-journal lathe head, which is also operated by a driving wheel, and can be attached to a table, and is an admirable appliance.

In grinding blocks and gum teeth, and often in plain teeth, very small wheels are required to make them fit the curves of the plate.

FIG. 893.

Thin edges of gum teeth and blocks must be ground with very fine-grained wheels; in jointing them a three-inch wheel should be used, perfectly flat on its outer side, and running very true (Fig. 886). Wheels when worn down to small size increase in value, because they grind out curves inaccessible to larger ones. In warm weather large and thin wheels, when not in use, should rest on a flat surface; such wheels are often warped by the softening of the shellac as they lie carelessly among other wheels. Wheels running on the end of a mandrel and attached by a screw chuck can be made to run true by warming the mandrel with a spirit lamp, and at the same time revolving the wheel rapidly.

The accuracy of the fit necessary depends upon the kind of work and mode of attachment to the base plate. In general terms it may be stated that whenever any permanent plastic material is in contact with the base of the teeth, or forms the bond of union between the teeth and plate, grinding is much simplified. It is sometimes better in such cases to have a moderate space between the base of the tooth and the plate or the model, than to have actual

contact. But in all cases the lateral jointing of block or single gum teeth requires care.

The order of grinding a set of teeth is usually to fit the central incisors, then the laterals, next the bicuspids, and so on; in case of

FIG. 894.

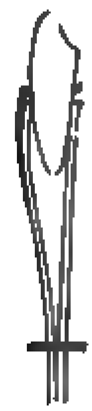


FIG. 895

FIG. 896.

FIG. 897.

sections, in the same order. This order will be found most conducive to uniformity of arrahgement; of course, it may be modified to any desired extent. In case of a double set there is much diversity

of practice. Some adapt, first, the entire upper set, others the entire lower; some, again, adjust the two sets of incisors, then the bicuspid blocks of both pieces, lastly, the molars. Whichever method is adopted, when all or part of one of the articulating rims is removed, the antagonizing rim must be retained to guide in the adjustment of the teeth.

Fig. 894 represents a holder for teeth while grinding; a slot admits the pins, and the side clamp holds the tooth securely.

During the process of grinding the teeth are temporarily attached to the plate in several ways. Either the articulating rim is cut away sufficiently to receive the tooth (Fig. 895), or the rim is en-

Fig. 896.

tirely removed and its place supplied with a mass of wax covering the plate to the top of the ridge, and to which the teeth are severally attached as they are ground; others fasten the teeth to the plate with cement. Dr. Richardson gives the following formula for a tenacious wax for temporarily securing the teeth: Beeswax, ℔ j; gum mastich, ℥ij; Spanish whiting, ʒj.

For melting wax and its compounds in temporarily attaching teeth to metal plates and for "waxing up" in plastic work, the

small Bunsen burners represented in Figs. 896 and 897 will be found very useful.

Fig. 898 represents what is known as the "Duplex burner," which is well adapted for laboratory use. To the usual Bunsen burner is added a large flame for the blowpipe, which is applied by rotating the upper portion upon the base. By means of a small jet either flame can be ignited, rendering it always ready for use.

An excellent "waxing burner" is shown by Fig. 899. The tube cannot be clogged with wax, as the heat will melt it and it will escape at the opening for the air-supply.

Definite rules of arrangement, or wood-cuts illustrating various forms of teeth and manner of setting them in the arch, are not all that is necessary. This branch of dental æsthetics must, of necessity, be worked out by every one for himself. He will succeed or fail

Fig. 899.

just in proportion as he has the ability to observe the hundreds of models which are perpetually before him, and as he has the further and rarer ability to apply his observations to the special cases that are in his laboratory.

Imitation of nature is the rule. Imitations of art and individual incapacity make exact observance of this rule comparatively rare. We replace the sixteen teeth with only fourteen, and often make them shorter and every way smaller than the natural organs. We do not make the grinding surfaces interlock with such deep cusps as in nature. At one time cannot avoid an unnatural fullness of artificial gum; at other times the contraction of the absorbed arch compels the setting of molar teeth nearer the median line than the original teeth.

Notwithstanding these and many other disadvantages the per-

fection of the dento-ceramic art is such that a skilled artist who is quick to observe what nature requires can in the majority of cases falling under his care supply the lost dental organs with great accuracy, and preserve that higher order of beauty which grows out of the harmony of his work with the expression of the face and entire person. But no dentist can give to his work this kind of beauty who does not systematically study the natural organs as they daily present themselves in the operating chair. Few patients would object to the pressure of a roll of wax (two inches long and about half an inch thick) against the closed teeth. A model from this impression would give the size, form, arrangement, and articulation of all except the molar teeth. A well-matched porcelain tooth (more than one might be required) would add to these data the color of teeth and gum. To this add also the age, sex, physical characteristics of the face, and the physical temperament. If the dentist would have a case-book for the registration of one such carefully made observation every week he would, at the end of two years, have a collection which as a practical guide in the selection and arrangement of artificial teeth would prove of incalculable value. These fixed records of minute details are made still more useful by a habit of close observation in society. In this way a set style, or mannerism, may be avoided, which so often stamps work with meaningless uniformity of expression.

Artificial teeth should imitate the natural organs; yet there is a perfection of form and arrangement which it is not advisable to imitate. To disarm suspicion as to their artificial character, it is often desirable to impart a measure of irregularity. An overlapping lateral, a missing bicuspid, a worn canine, an incisor, bicuspid or molar apparently decayed and filled with gold, an exposed neck from absorption of the alveolus, are among the legitimate devices of the skillful mechanician who has the "art to conceal his art." If there are any defective natural teeth remaining to be matched, still higher art is required. A perfect porcelain incisor is no fit companion for one that is partly broken, decayed, and discolored; and since no art can make the defective tooth perfect, and yet the patient retains it, there is no alternative but to give so much imperfection to the artificial one as shall take away that striking contrast which so painfully offends our æsthetic sense of fitness.

In this class of operations a "diamond drill" is of great value; in fact, so very useful is it in many ways that we regard it as an absolutely indispensable instrument in the laboratory. Cutting away parts of teeth or blocks inaccessible to wheels; changing the shape of teeth near the gum; drilling cavities to be filled with gold,

or holes for the repair of broken blocks, these are some of the operations which the diamond drill will accomplish as no other instrument can.

The selection and grinding of artificial teeth require, first, a high order of æsthetic culture; secondly, great patience and skillful manipulation. The latter are often taxed to the utmost to make a set of blocks answer the requirements of a given case; especially when the blocks must be closely fitted to a gold plate preparatory to attachment by soldering. Single gum teeth are more easily fitted to the plate; but there are some joints; hence it is doubtful if much time is saved. The principal advantage of single gum teeth is that a single tooth, if broken, may be replaced without interfering with the adjoining ones. Another reason why many prefer them is that a small stock of teeth in this form is adapted to a larger variety of cases than blocks would be.

We think, however, that dentists living at a distance from the manufacturer should depend upon a great variety of samples rather than upon duplicates of certain forms, however desirable.

In jointing a set of blocks or single gum teeth one point must be remembered which has already been alluded to. In soldering the

Fig. 900.

Fig. 901.

metal expands, while the teeth held in the investment are brought closer together by its contraction, and in this slightly altered position they are soldered to the plate. The contraction of the plate on cooling is irresistible and may result in one or both of the two accidents—chipping off the brittle edges of the teeth thus brought too closely together, or warping the plate because of the resistance which the teeth or blocks offer to the contraction of the plate. Thin letter paper slipped between the side joints will suffice to prevent these accidents.

Fig. 900 gives an external view of a full upper set of single gum-teeth, arranged on a gold plate, preparatory to the operations which precede soldering, or other modes of fastening them to the base. Fig. 901 is a similar view of a set of blocks, with a soldered rim covering the upper edge.

Usually, in first or temporary pieces, and sometimes after the

alveolar absorption is completed, the fullness of the gum is such as to forbid the addition of an artificial gum to the ten incisors, canines, and bicuspids. In such cases the plate must be cut away from the front of the ridge as far as the first or second bicuspid, and the teeth ground with great accuracy to fit the gum itself. Single plain teeth will usually be best adapted to such cases; but an excellent effect can sometimes be produced by grinding a block, when the shade of gum is well matched, to fit directly upon the natural gum. In partial cases the tooth or block must invariably be fitted to the gum; no plate should be seen above or at the side. In fitting directly to the plaster model this should be scraped (after the tooth is ground), so that it may press firmly on the corresponding gum.

The teeth or blocks being now arranged and fitted to the plate, the next step, preparatory to soldering, is to get access to the pins on the inside for the purpose of backing them. Set the articulating model on the table with the teeth upward; bend a strip of lead (an inch wide) outside the arch and about half an inch from the teeth; then fill the space with plaster, inserting a strip of tin foil opposite the median line, so that the plaster rim will readily break at that point when removed. In a double set do the same with each half

FIG. 902.

FIG. 903.

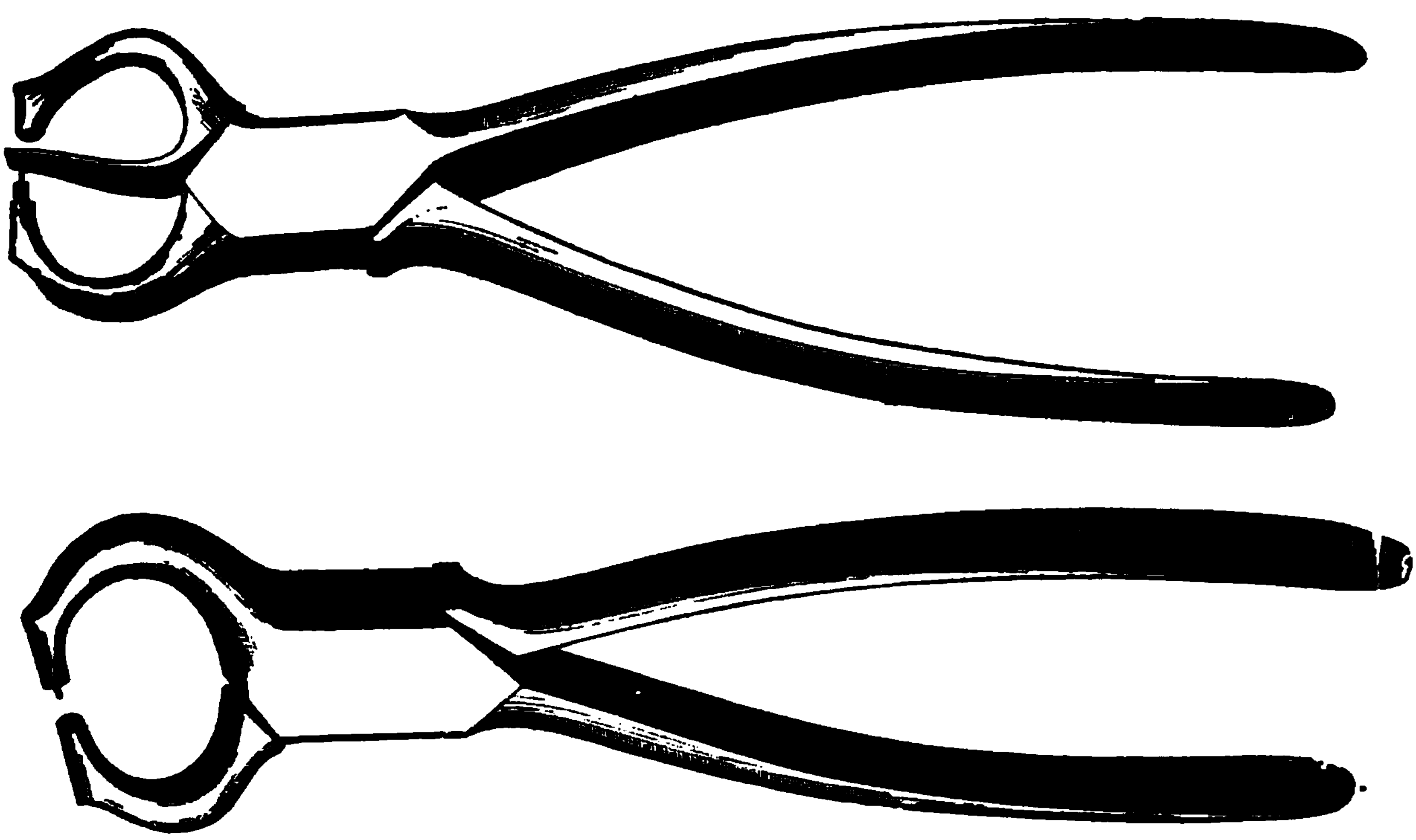
of the articulator. When the plaster has set remove all wax or cement from the teeth and plate, and proceed to examine the pins, also the relations of the teeth or blocks to the plate and to each other. This temporary plaster band we regard as essential in every case, except a few varieties of partial sets. It is equally essential in vulcanite and other forms of plastic work, as will be hereafter explained. It is a common but not good practice, where the teeth are soldered, to substitute for this temporary band the soldering investment.

Fig. 902 will give an idea of the shape of this rim, except that, being here designed for a different purpose, it does not show the impress of the teeth. Fig. 903 represents the inner surface of a set of

blocks with the wax removed, which we may suppose just withdrawn from the plate in the preceding figure. Blocks or sections are readily replaced in their proper positions; but single teeth are sometimes so similar, especially bicuspids, that they are apt to be misplaced. To prevent such accidents have a circular wooden block four inches in diameter, with twenty-eight cups or depressions, so marked that each tooth can be instantly put into and taken from its proper cup.

The teeth being thus arranged, a gold plate or backing large enough to cover the entire width, and from eight- to nine-tenths of

Fig. 904.



the height of the posterior surface of each, is fitted to them in the following manner. Each tooth has securely fixed in the back part of it two platina rivets for the purpose of connecting it to the backing. Each backing, therefore, should have two holes punched through it by means of a pair of punch forceps, as represented in Fig. 904, large enough to admit the rivets of the teeth. After having punched one hole a rivet is inserted; then by moving the strip of gold plate two or three times to the right and left a mark will be left upon it, indicating the distance the rivets are apart. But previously to this the rivets should be made parallel (being very careful not to strain them in the tooth) and the ends filed off level. Otherwise the pins will not go into the holes punched, and there will be an uncertainty as to which side of the pin the mark on the plate corresponds.

Dr. Samuel Mallet has very ingeniously invented a punch which

will save much trouble in finding the proper position of the second hole (Fig. 905). After straightening the pins one is placed in the hole, *i*, at the head of the punch, the other pin pressing out the movable punch, *e* (which works by the spring, *g*), until it slips into the slot, *h*; the two punches, *f e*, then make the holes at the exact distances apart to receive the pins.

A simple form of punch, and one not liable to accident, is a piece of steel half an inch square and three or four inches long. It consists of two halves riveted together at the top, each tapering nearly

FIG. 905.

to a point. By turning a small screw, inserted midway in one leg, the points held opposite the pins are separated to their exact distance. A slight tap of the hammer marks this upon the backing, and then the holes are made with an ordinary punch. Pins often

FIG. 906.

set very irregularly in a tooth; they should be parallel, but not necessarily perpendicular. Too much bending of a pin close to the tooth makes it more liable to fracture in soldering or by use in the mouth. Pins also vary much in thickness; it is better to have the pin of the punch forceps of medium size, and to ream with a broach

for large platina pins. A set of broaches are indispensable in backing teeth and in many other operations.

The holes should be slightly countersunk on both sides, and after placing the backing on the tooth it is made fast by splitting with a strong knife or a wedge-shaped excavator the ends of the platina rivets or pinching them together with pliers. If the ends of the platina rivets are hammered so as completely to fill the holes in the backings, it will prevent the solder from flowing in and uniting the two as firmly as it should do. The backings should be slightly hollowed before they are put on; by so doing they will fit up closely to every part of the back of the tooth. Fig. 906 represents a pair of forceps designed to give a general form to the backing by punching it from a piece of gold plate of the required thickness.

After the backings have been made fast to the teeth they are to be accurately fitted to the plate, standing off from the plate enough for a very thin piece of watch spring to be passed under it. This shows that the tooth is not raised by the backing from its place in the investment. A much wider space makes the flow of solder uncertain; the practice of placing scraps of gold under badly-fitting backings is a very slovenly one; and where such imperfections occur it is much better to fill such spaces with gold foil.

Some dentists back the teeth as they grind and fit them and before investing; others invest with the plaster and sand, and back without taking them from the investment; others, again, partially invest with the soldering mixture, remove, and back the teeth, then replace, and add more plaster and asbestos or sand over the edges of the teeth. The last method is unsafe, because the two layers of batter are apt to separate in heating and may displace the teeth.

Backings (called also stays or standards) vary much in size, shape, and thickness. Some variations are matters of taste; as, whether they shall be rounded, square, or beveled at the top corners; whether chamfered to a thin edge, or left thick, and then beveled or rounded. But other points often considered optional are not so, inasmuch as they affect the appearance or stability of the work. Backings which cover the translucent edge of the tooth darken it by the refraction of the oxidized surface next the tooth, and which cannot he kept bright; even if it could, the gold would impart a yellowish tinge. They should cover enough of the tooth, and fit so accurately as to prevent motion of the tooth; for this will inevitably cause the pins, sooner or later, to break off. Backings, in relation to each other, must either be so far apart at their base that the solder will not flow from one to the other, forming a continuous band, or they must be in contact throughout whatever

distance the solder will unite them. This rule is particularly applicable to backings of single gum teeth, which are often (perhaps usually) made the full width of the tooth up to the shoulder. This continuous band gives great stiffness to the plate. But the contraction of the solder will certainly warp it, unless prevented by actual contact of the edges soldered. In case of plain teeth a heavy, continuous line of solder will almost certainly warp the plate. A block may be backed for soldering in one piece, or in parts closely fitted, or in distinct backings opposite each tooth. A block much curved is with difficulty backed in one piece; long or thin blocks are liable to be cracked by the contraction of a backing, either in one piece or made continuous by soldering. Backings should be of the same gold as the plate, but heavier, especially if long or large.

Sometimes the shape of a gum or block tooth may require the removal of the plaster rim, which can readily be done; then replaced after the backing is completed for the final adjustment of the teeth. The teeth are next to be fastened to the plate with a small quantity of cement (resin mixed with wax, or, still better, the wax, gum mastich, and whiting compound), and a small roll of softened wax (not melted or made adhesive) placed over the entire surface to be soldered. In Fig. 907 the inner band may be taken to represent the width of this wax roll, which is of great service in preventing any plaster of the investment from getting accidentally upon the parts to be soldered. If the teeth have been previously soldered to the backings this wax strip should be narrower; but if rivets and backings are to be soldered at the same time, the rim must be made carefully to cover every point where solder is to flow. The plaster band is then very carefully removed and the piece surrounded with the soldering investment, which must be no thicker than is sufficient to protect the teeth and hold them in place. The wax and cement are easily removed, leaving the surfaces perfectly clean and ready for the borax and solder. The investment should not project so far over the inner edge of the teeth as to obstruct the blowpipe flame; it should not cover the lingual surface of the plate, nor should it be thick on the palatine surface. On the palatine side it might be well also to cut along the median line nearly or quite through the investment; the object of this is to give play to the lateral expan-

Fig. 907.

sion of the plate, the antero-posterior expansion being usually, from the shape of the plate, sufficiently free. This we regard the simplest and best method to prevent warping of the plate, so often caused by the very means taken to prevent it.

We have said nothing of fastening the teeth with a firm body of cement instead of wax, so as to try them in the mouth before soldering, because a correctly taken articulation makes this unnecessary. As remarked in the chapter on articulation this process admits of perfect accuracy. Its very object is to prevent the necessity of any change in arrangement after teeth are adjusted. An error of articulation will often involve a change in the jointing of blocks more troublesome than the original grinding; in fact, neatly ground blocks (or gum teeth) will not permit the slightest change of position without fresh grinding somewhere. Trial of teeth, merely to test the correctness of articulation, may in some cases be especially necessary when used to test correctness in the selection of teeth; for it requires experience to enable us to determine, *a priori*, just what style of work is best adapted to the case. But the awkward and momentary retention of a plate to which the teeth are so slightly attached is no test of its æsthetic correctness, unless the selection has been grossly misjudged. It is only after the patient has become habituated to the piece, giving time for the natural form of the lips and motions of the mouth, that we can best decide whether or not our work has beauty of expression as well as artistic finish.

Mr. Andrew Wilson, of Scotland, adopts the following method of backing teeth: After having partially fitted the tooth to the plate, take a piece of platina foil, as thick as can be used conveniently, and, pressing it against the tooth, perforate it where it is marked by the pins; then cut it into the required shape of the backing and press it as closely as possible to the back of the tooth. Apply a little borax to the platina pins which come through the back; then place the tooth, with its face downward, upon a thin piece of pumice, covered with dry plaster, putting upon the platina sufficient gold for the thickness required; slowly heat it, gradually raising the heat until the gold melts, when it will rapidly flow over the whole platina surface, uniting so firmly with the pins in the tooth that Mr. W. has never, during eight years' use, seen a case in which they have loosened, even where there has been sufficient violence to break the tooth. After the backing has been run and the tooth allowed to cool slowly, it is filled to the requisite thickness and shape; tooth and backing are then closely fitted and finally soldered to the plate. In arranging the teeth on the plate for soldering,

Mr. Wilson uses an investment of white sand and plaster, equal parts, placing a thin strip of platina on the outside of the teeth, with a layer of the investment on both sides of it, so that, should the plaster crack in soldering, the platina may keep the teeth from shifting their places. The whole time occupied in heating and backing a tooth is about half an hour; when several are done at once a little longer time is required. Of course, all the backings of the set should be flowed at the same heating.

Instead of using the strip of platina plate to prevent the teeth from becoming displaced, in case the plaster cracks, thin sheet-iron rings one inch deep or iron wire may be used; but platina is

Fig. 908.

undoubtedly the neatest, and has the advantage of being indestructible; it may be narrow and thin, so that its cost would form no objection to its use. But if the plaster is not in excess the investment will not crack. A batter made of three or four parts of asbestos to one of plaster will stand the hottest fire of the laboratory. Many prefer equal parts of plaster and sand, as forming a more solid investment in which to back up the teeth. Mr. Wilson's method might be improved, first, by completely fitting the tooth

before backing; secondly, by running the thin platina backing one-sixteenth of an inch on the plate, to any irregularities of which it can be quickly burnished down. This flange secures a very perfect and strong attachment to the plate, and is the method of backing (with heavier platina) sometimes practiced in the continuous-gum work.

Ordinary backings, after they have been fitted to the plate and held to the teeth by bending or splitting the pins, may be removed from the plate, set in a batter of plaster and asbestos, and soldered; the plaster should be so stiff as not to flow over the backings. The solder should be rather harder to fuse than that used to fasten the teeth to the plate. The backings, after slowly cooling, should be filed, and may even be Scotch-stoned. Backings can be better and more quickly finished singly than when attached to the plate. This method, or Mr. Wilson's, is much to be preferred to the common practice of soldering the backings to both teeth and plate at the same heating.

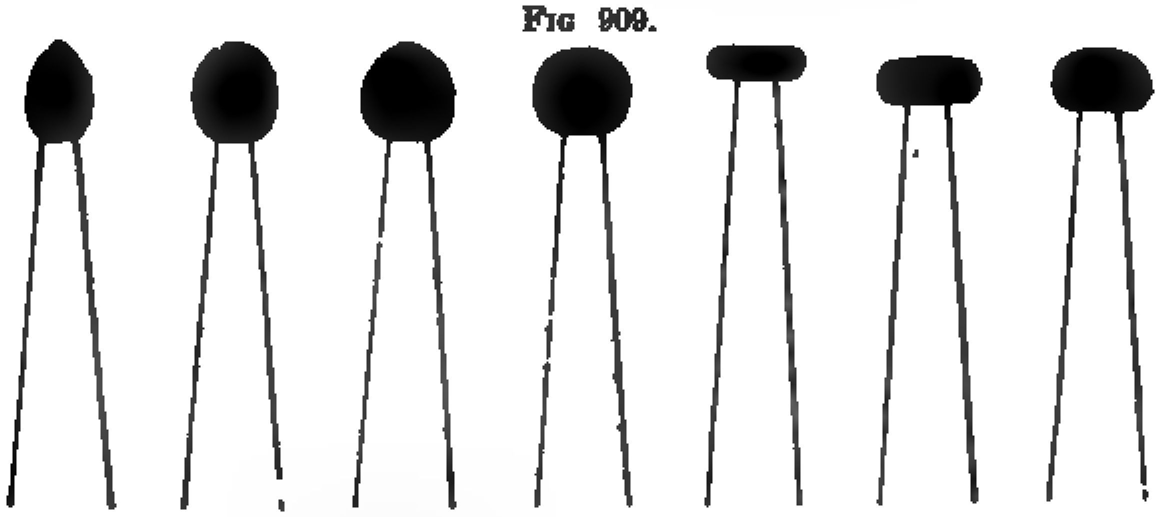
A piece invested preparatory for soldering and placed upon a lump of solid charcoal is seen in Fig. 908.

Directions for applying borax and solder have already been given. Some cut the solder into very small pieces; others use one piece to each tooth at its base, and a second for the pins unless previously soldered; in the figure the pieces are unnecessarily small. If the backings are soldered to the teeth beforehand a more fusible grade of solder should be used at the second soldering. The work, as before stated, must be very gradually and thoroughly heated up before directing the flame upon the plate or backings. The last point to be touched with the flame is the solder, and this not before a slight melting of the edge shows that it is just on the point of flowing. If every preparation for soldering has been properly made the actual flowing of the solder on a full piece will take less than a minute, and will be so smooth as to require no other finish than the Scotch stone and the polishing wheels. After soldering, the cover should be placed upon the soldering pan (Fig. 884) and the work allowed to become quite cold before removal; when a charcoal lump (Fig. 908) or pumice stone is used the work must also be covered while cooling.

Finishing Process.—When the piece is cold it may be placed in water to soften the plastic investment, which should be carefully removed from the teeth; the set is then placed in a glass or porcelain vessel containing a mixture of equal parts of sulphuric acid and water, and heat applied. As soon as the borax (which, by the process of soldering, has lost its water of crystallization and as-

sumed a glassy hardness) is decomposed, the vessel is removed and allowed slowly to cool. This process is termed by jewelers "pickling," and requires from ten minutes to half an hour for its completion, according to the strength of the acid and the quantity of vitrified

Fig 909.



borax on the plate. After this the acid is washed from the piece; or it is still more effectually deprived of acid by boiling in water containing a little caustic soda.

In removing the roughness which may have been occasioned by imperfect soldering, care must be taken not to cut away too much

Fig. 910.

of the plate. For this purpose scrapers, files, and lathe burrs are used, according to the position and quantity of surplus solder. Fig. 909 represents a set of solder burrs for trimming off superfluous solder. After the work has been made as smooth as possible

with scrapers, etc., it should be rubbed with pieces of Scotch stone and water until every scratch is removed; some use a fine, smooth cork attached to the lathe, and charged with water and powdered pumice or silex. The piece is then polished with Tripoli, applied by means of oil or tallow to a brush wheel (Fig. 913), which is made to revolve rapidly against the work. Felt, rubber, walrus leather, and cotton wheels and cones are also employed in polishing. Fig. 910 represents a felt wheel and cone. Fig. 911 shows one of the various forms of vulcanite burrs for carrying polishing powders. As to the rapidity with which a lathe should be worked: drills and burrs require a slow movement; corundum wheels a quicker one; rotten stone a rapid motion; and whiting, zinc-white, or rouge the most rapid of all.

The piece may now be placed in a porcelain vessel containing the following mixture: nitre, 2 ounces; salt and alum, each 1 ounce—dissolved in 4 ounces of water. After boiling for half an hour in this to decompose the copper from the surface-layer of the solder and plate, it is boiled a few minutes in a solution of 1 ounce of caustic soda in 4 ounces of water to neutralize the acid, then washed with a brush in pure water.

The removal of the copper from the surface of the plate gives to the gold the beautiful orange hue, which is its natural color, and which it will retain until the friction of mastication wears off this surface. The secretions of the mouth will fail to tarnish it; and it will be free from the disagreeable taste of which so many complain who wear artificial teeth set on metallic plate. But when plate is made from coin without alloy, or is of 20 carats fineness, and the solder has a corresponding quality, the pickling process may be omitted.

The process of finishing is completed by polishing every part of the lingual surface of the plate, backings, and clasps with highly tempered and finely polished steel burnishers. Fig. 912 represents various forms of plate burnishers. They should be frequently rubbed on a piece of wet Castile soap, and carried backward and forward in the same direction over the plate until every part of the gold exhibits a high polish. Burnishers of different shapes are required for different parts of the work; bloodstone burnishers are also used.

A piece, however, can be polished in less time, if not more perfectly, with brush wheels (Fig. 913). Brush wheels vary in diameter, thickness, and material. Bristle wheels vary in stiffness and length of bristle; the stiffer being used for Tripoli or rotten stone, the softer for whiting and rouge. Cotton is often substituted for bristles; buckskin or felt are also much used for wheels or circular "laps," and are especially useful in dressing up the recesses

of a plate. It is of the utmost importance that wheels or laps used for different polishing substances should be kept entirely separate; a little Tripoli or pumice powder on a rouge wheel may render useless the work of an hour. The brush should be set on the

FIG. 911.

FIG 912.

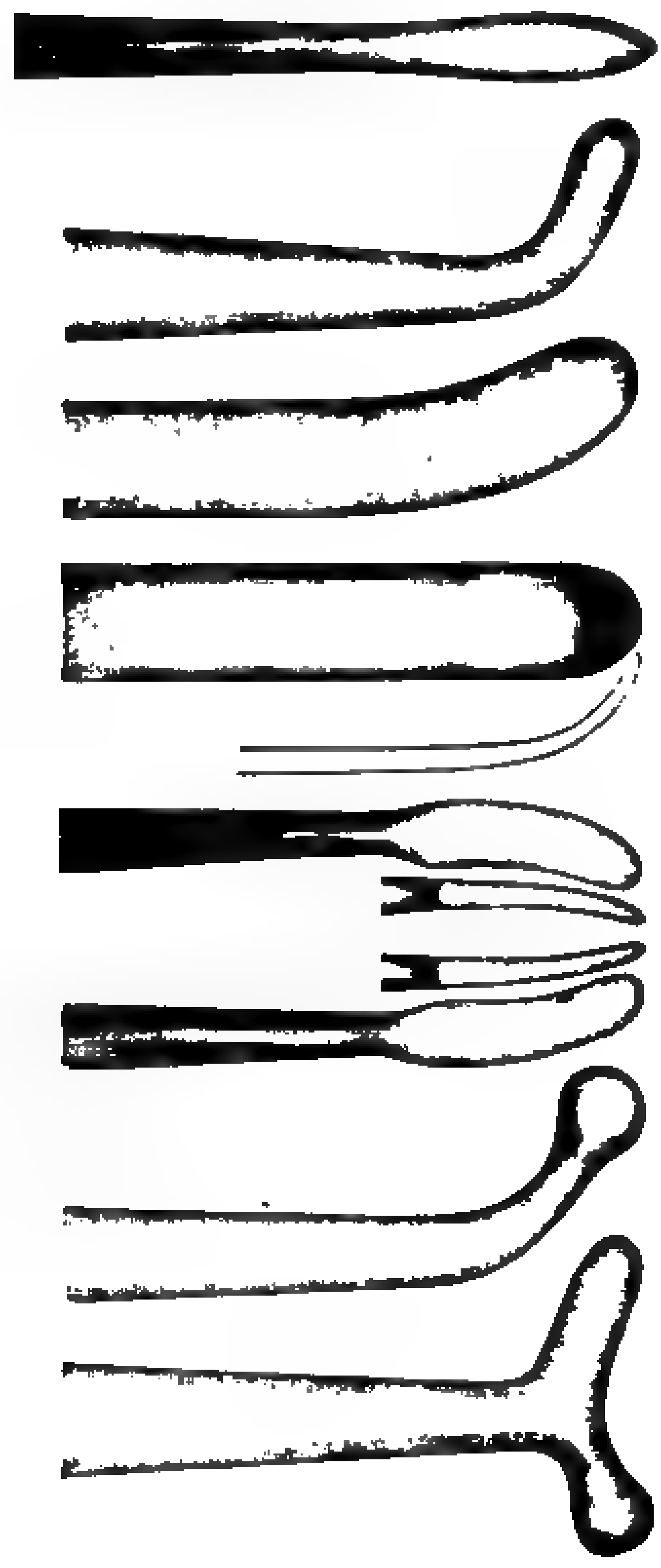


FIG. 913.

spindle of the lathe, then lightly smeared with suet by holding a small piece against it while it is revolving. The rotten stone is applied in the same manner, and with the brush thus charged, the

polishing may commence; but the plate must not be exposed too long to the friction, as it will rapidly wear away the pure gold surface brought out by the pickle; hence some use only the burnisher or rouge after pickling. Tripoli has a sharper grit and cuts more rapidly than the ordinary rotten stone; but the latter gives a very smooth surface, and will in most cases give a sufficiently brilliant finish without rouge. A very high watch-case finish can only be given by very rapid revolution of wheels or buffers, charged with the finest quality of rouge, wet with alcohol. The piece must be previously washed with soap and water, so as to remove every trace of oil. Sometimes rouge is applied on a piece of soft buckskin, wrapped or sewed around small, blunt-pointed pieces of cork or wood. The lingual surface of the plate is the only one that should be polished. The dead color of the palatine surface throws out the polish of the other side and greatly improves the appearance of the piece. The adhesion of a plate is frequently improved by roughening the plate with a file or by engraving lines upon it. The process of finishing on a gold piece, properly soldered, is a very simple matter, and one of secondary importance. A set with a Scotch-stone finish is in every respect as useful and æsthetically as beautiful as the most highly polished plate. There is, however, no objection to this sort of appeal to the eye, provided it is not the chief merit of the work.

There are three methods adopted for the retention of dental plates, and many modifications of form required by the various circumstances of different mouths. An enumeration of all the required forms would be impossible in this work; but we hope to represent a sufficient variety to enable the operator to decide which is best for any given case. We think it far more important, however, to endeavor to explain, as far as can be done, the principles which determine these different forms and modes of retention, than to lay down any set of didactic formulas for unreasoning adoption.

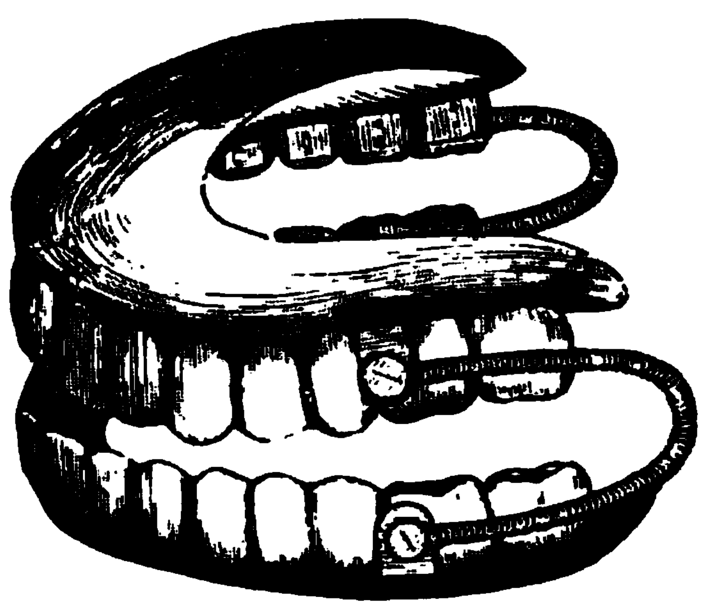
CHAPTER XIII.

RETENTION OF BASE PLATES—THEIR SIZE AND FORM OF OUTLINE.

THE utility of a piece depends largely upon the firmness with which it keeps its place during mastication or in conversation. The means adopted to secure this are fourfold: The first two retain the plate by extrinsic support; the last two depend upon an intrinsic

quality of the plate itself. 1. Spiral springs, by constant pressure, keep the plates of a double set in position. 2. Clasps, by grasping some natural tooth, hold a partial piece firmly in place. 3. Spring plates, which are constructed of vulcanized rubber, and are available only in partial cases. 4. The close adaptation of the plate, whether of a full or partial set, causes it to adhere with a force which is lessened, first, by the amount of air between the surfaces; secondly, by the liability to displacement. These modes of retention will be considered in the order named.

FIG. 914.



Spiral springs, formerly very much used, are now seldom employed; they are applied only to double dentures. Fig. 914 gives a correct idea of the position of the springs, their points of attachment, length, and direction of curvature. Fig. 915 represents the detached portions of the spring, consisting of standards, screws, tangs, and spiral coil. The tendency of the curved spring to straighten presses each plate upon the alveolus, acting at the points of attachment of the standards. These points are chosen, first, in the upper jaw, as nearly as possible on the line of equipoise, which will be somewhere between the centres of the second bicuspid and of the first molar; secondly, in the lower jaw, where a vertical line from the upper standard meets it. Perforated bicuspids and molars are sold, adapted to such cases; and the usual plan is to attach the standards before soldering the teeth. A more accurate method is to determine the position of the standards after the pieces are finished. The presence of the teeth makes soldering of the standards more troublesome, but not impossible; they may also be riveted to the outer rim of the plate. With the diamond drill holes can be made through the teeth or blocks opposite each standard.

FIG. 915.

Directions for making the coil have already been given; they are usually purchased ready made. Their length must be such that the curve will not irritate the ascending ramus of the lower jaw. If too stiff their forcible pressure will irritate the gum; if too slight they will fail to keep up the piece. The tangs are held in the coil by closeness of fit; when loose they may be tightened by floss silk. The screws represented in the figure are troublesome to make, and are very apt to loosen. A better plan is, to pass a headed pin through standard, tang, and tooth, and rivet or solder it in the backing. This plan makes the tang permanent; the pieces are separated by detaching the upper or lower tangs from the coils. It adds greatly to the strength of the pin to pass it through the tooth or block. There should also be a shoulder on the standards to limit the movement of the tang; else the springs, by too great upward or downward motion, may irritate the mouth. It is unnecessary, in view of the present limited use of springs, to describe other and very ingenious methods of attaching them.

Their use is now confined, first, to very flatly-arched upper jaws, usually small, covered with hard membrane, and having the attachment of the facial muscles close to, or quite upon, the ridge; also to lower cases where all trace of the ridge is gone. Secondly, to pieces inserted so soon after extraction that the rapid absorption will quickly destroy the adaptation. We shall speak elsewhere of other means adopted to meet these exigencies, in failure of which spiral springs are to be used. But they are troublesome to make, annoying to wear, difficult to keep clean, and liable to accident; hence we only use them as a last resort. In conclusion, it should be noticed that the upper plate of spiral-spring pieces does not cover the palate, but is shaped more like the lower piece. This is one of its compensating advantages; for it is an objection to the otherwise valuable principle of atmospheric pressure that it covers so large a portion of the mucous surface.

CLASPS.

This method of retention, necessarily applicable only to partial pieces, has fallen into much disfavor, and given place to methods in lieu thereof which are really more objectionable. But, like many other time-honored practices which modern dentistry has thrown in its waste-basket, there are very decided advantages in this mode of retention, which make it in certain cases the best possible one. The disuse of clasps has grown out of, first, their injurious effects, due to improper construction and injudicious application; secondly, the difficulties of making a clasp piece. We venture the assertion that

one-half the dentists do not really know how to make a perfectly adapted clasp piece; and that of the remaining half two-thirds will not take the trouble. The tediousness of clasp adjustment is out of place in that rapidity of manipulation demanded by the cheapness of modern dentistry. Nor can we expect to see the easily made but ineffectual vacuum cavity give place in turn to the clasp attachment, which it has to such an extent superseded, until the profession becomes awakened to the necessity of substituting good work for fast work—economical high-priced work for expensive low-priced work; until the mechanician so far respects himself as to value his labor more than the cost of his materials, and ceases to use certain substances because they are cheap, rather than others because they are better.

Next to pivoting, the clasp is the most secure of all methods of attaching artificial teeth in partial cases. But it is not universally applicable for reasons hereafter stated. In deciding upon the propriety of using clasps the remaining teeth must be carefully examined to determine whether, in shape, position, texture, and relation to other teeth and to the proposed plates, there are many which admit of being clasped. If there are such teeth, a perfect impression of them is necessary; then greatest accuracy in fitting the clasp; lastly, a most exact adjustment of this to the plate, to which it is to be fastened with great care. Scrupulous observance of these points, in connection with a properly fitted and shaped plate, will take from clasp work the force of the objections urged against it.

In the selection of teeth to be clasped the points for consideration are: 1. Their condition: never clasp loose teeth or those where there is much alveolar absorption; or, if possible to avoid it, those which have filed surfaces. 2. Their shape: avoid all conical teeth, such as third molars and canines; also teeth considerably larger at the grinding surface than at the gum. The proper shape for clasping is the cylinder, or rounded prism; and only so much or such part of any tooth should be clasped as has this shape. Hence it is that thick, narrow clasps are best, because few teeth have much breadth of cylindrical shape. 3. Their position: incisors, canines, and third molars must be rejected for this reason; and second molars are unfit, if the plate holds incisor teeth. The incisors and cuspids are of all the teeth less suited for the attachment of a clasp. It is exceedingly difficult to apply clasps to these teeth in such a manner as to retain even a single tooth with sufficient stability to be worn with any degree of comfort. We remember once to have seen a case in which a central incisor (natural tooth) was in-

serted and kept in place by a gold wire projecting from each side of the tooth into holes drilled into the adjoining teeth. A stage of dental progress that permitted such a process might also have allowed the clasping of incisors; but we know of no possible circumstances that will justify, in the present state of dental art, the clasping of any of the six front teeth. No lower teeth should be clasped; but in some cases a stay (half-clasp) may be used. The best teeth, in respect of position, are the second bicuspids; next, the first molars; thirdly, the first bicuspids; and lastly, the second molars. These eight teeth are the only ones that should ever be clasped; and if possible the choice should be confined to the first four. 4. Their relation to the plate and to the other teeth. Let the clasped tooth be as near the line of equipoise as is consistent with other considerations. For incisors alone we should, for this reason, give preference to the first over the second bicuspids; and in case of the loss of the ten or twelve anterior teeth we should use no clasp on the remaining molars. Teeth not decayed should never be separated from others with which they are in contact for the purpose of passing a clasp. If no other tooth can be found a stay (half-clasp) must suffice.

Observance of the conditions above enumerated restrict very much the range of cases that admit of clasps. In the matter of position and relation to the plate, circumstances may compel a choice not the most favorable to success; but in other respects it is far better to dispense with clasps than to apply them so as to incur risk of failure or injury to good teeth.

The liability to decay of the tooth around which a clasp is applied is always greatly increased by the removal of any portion of its enamel. The application of clasps to diseased or loose teeth always aggravates the morbid condition of the parts, and causes the substitute, which they keep in place, to become a sort of annoyance to the patient. Besides, such teeth can be retained in the mouth only for a short time, and when they give way the artificial appliance becomes comparatively or entirely useless; and even before their loss it is not held firmly in its place. Its instability exposes its presence to the observation of the most careless observer, and this motion is injurious to all the teeth near or against which the piece comes. In the lower jaw parts of sets are much less frequently called for than in the upper, and when they are, the use of clasps may be dispensed with altogether. A clasp can seldom be applied advantageously to a lower molar. The lower front teeth are least liable to decay of any in the mouth, and therefore do not require replacement, except in full sets, unless lost by a blow or by the

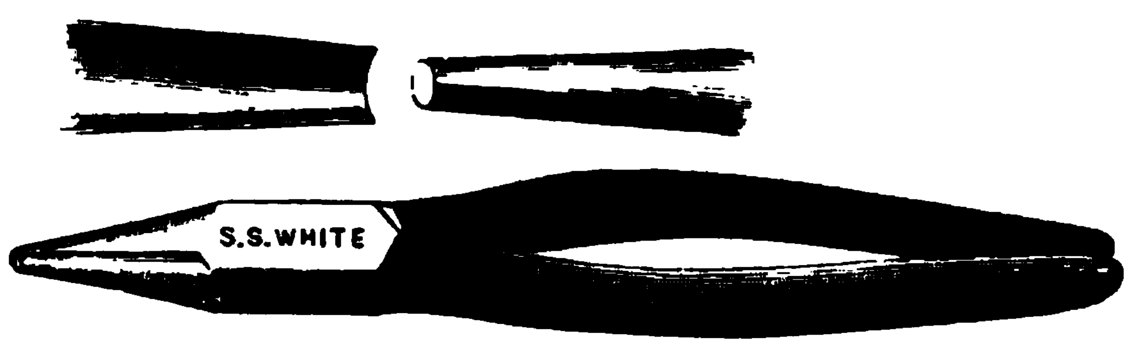
destructive action of salivary calculus. A partial lower front piece calls for half-clasps or stays; but other partial lower pieces (replacing bicuspids and molars) should not depend for their stability upon any remaining bicuspid or cuspid.

If the injurious effects liable to result from the application of clasps to teeth selected according to the rules given could not in any way be counteracted, dental substitutes retained in the mouth by this means would, in the majority of cases, be productive of more injury than benefit; but they may be in great measure prevented. They are not caused, as many have erroneously supposed, solely by the mechanical action of the clasps upon the teeth, but also by the chemical action of the secretions of the mouth and decomposing particles of food. The method of measurably preventing these deleterious effects is twofold: First, to prevent the chemical action, the removal of the artificial teeth and thorough cleansing of them and the natural organs; this should be done every night and morning, and the teeth rubbed with a brush and waxed floss silk until every particle of clammy, vitiated mucus and foreign matter is removed. The inner surface of the clasps should be freed from all impurities, and the whole piece cleansed with a brush and water. Secondly, to prevent or lessen the mechanical action the clasp should, as before remarked, fit with great accuracy the parts of the tooth protected with hard enamel; the whole piece should have such closeness of adaptation as to prevent motion of the clasp upon the tooth. We have elsewhere spoken of other injurious consequences of clasps placed too near the gums or exposed necks. Rapid decay and breaking off of the teeth, inflammation of the gums, of the peridental membrane, destruction of the alveoli and loosening of the teeth, are among the common results of the clasping of teeth as it is too often practiced. Consequences such as these have led many to an unqualified condemnation of this method; yet, as we have said, when suitable teeth are selected for clasping, and the work is properly executed, it is the best and most durable way in which a partial piece can be secured.

Shaping and Adjusting Clasps.—The gold employed for clasps should be about one-third or one-half thicker than the plate, and as wide as the cylindrical portion of the crowns of the teeth to be fitted. Some clasps are best made of half-round wire, and narrow; others may be broader and thinner; thick, narrow clasps are more universally applicable. In quality it is better that clasp and plate be the same, except when the plate is of pure coin. In this case add copper (but no silver) to give elasticity. Platina, often used for this purpose, imparts too much brittleness, after the piece has

been worn for some time. Some may fit the tooth close to the gum; but in other cases the shape of the tooth, absorption of the alveolus, or morbid sensitiveness of the neck, forbid this. Enamel surfaces best resist the wearing action of clasps; dentine, exposed by the file or chisel, is more liable to abrasion or decay; cementum should in no case be brought in contact with clasp or plate. If the clasps chafe against sensitive parts, inflammation of the peridental membrane may be set up, followed by wasting of their sockets and ultimate loss of the teeth. Fig. 916 represents a clasp bender.

FIG. 916.



With the plate in position in the mouth, a wax impression may be taken; the plate, adhering to it, on being withdrawn, will have a correct relation to the teeth which are to be clasped. Others adopt the less accurate method of adjusting the plate to the original plaster model. But as, for reasons before given, it is advisable to cut off the teeth from the model used in moulding, a second model is necessary, and usually for this purpose a second impression. Moreover, if the mouth has marked irregularities or rugæ, and the plate covers much surface, it cannot be fitted upon a plaster model so as to hold the same precise relation to the teeth as when in the mouth.

When accurately fitted, clasps may be at once soldered on the model, or may be attached to the plate by means of a small piece of wax or cement composed of one part wax and two of resin, softened modeling composition; this should be softened and applied to the plate and to the inner side of each clasp. The plate and clasps thus united are carefully removed from the plaster model and laid with the convex side downward on a piece of paper. Plaster is then poured on the upper side of the plate, covering it and the clasps to the thickness of half an inch. After this has set the piece may be taken from the paper, placed on charcoal, the wax being softened and removed, and prepared for soldering.

This is the simplest way of fitting clasps to the plate and preparing the piece for soldering; but when the clasp teeth deviate from a vertical position, or when the teeth are of such a shape that the wax impression does not copy them accurately, this method is

in such cases not reliable. The clasps must be fitted to the teeth in the mouth, instead of on the plaster model, and may then be attached to the plate as just directed. Often only one can be attached at a time, and after this has been soldered the piece is replaced in the mouth, and the other made fast to the plate. The greatest care is necessary to prevent altering the position of the clasp in taking the piece from the mouth.

The following is Dr. Fogle's method for securing accurate adaptation of the clasps. They are first fitted to the plaster model, leaving the ends straight. A narrow strip of plate about five-eighths of an inch in length is used as a temporary fastening, one end of which is soldered to the lingual surface of the clasp; the plate and clasp are now both placed on the model (made from impression taken while the plate is in the mouth), and the other end fitted and soldered to the plate, forming a sort of semicircle or bow. Fig. 917 represents the plate, clasps, and temporary fastenings on the plaster model. In Fig. 918 they are seen separate from the model.

Fig. 917.

Fig. 918.

The clasps are now adjusted to the model; however accurately this is done, it will be found, on applying the plate to the mouth, that they will not fit the teeth there. After properly adjusting them the temporary fastenings will be found sufficient to hold the clasps in their exact position while the piece is being removed. This done, it may be invested, placed on charcoal, and the other steps connected with the process of permanent soldering gone through with, detaching the temporary fastenings when the investment has fixed the clasps in position.

Dr. Cushman advises, in very difficult cases of adjustment, as where the clasp teeth are much inclined, and where you have to fasten to second molars, a slight modification of this plan. After soldering one end of the strip to the clasp, and having bent the

other to touch the plate when on the model, put both in their proper place in the mouth; then, with a sharp-pointed instrument, indicate the point where the bow touches the plate; place them on the model again; adjust the end of the bow to the point marked; confine it there and solder fast. Dr. Cushman considers Dr. Fogle's method of adjusting clasps so valuable that he never ventures to set clasps permanently, even in the simplest case, upon the original model with the plaster teeth as the only guide for position.

Dr. Lester Noble's method is as follows: Place the plate in the mouth, and let the clasp bind upon the tooth with only sufficient firmness to keep it in its proper place. Then mix a small quantity of plaster from a lot which, by previous trial, you find requires four or five minutes to set; put it upon a piece of paper or sheet lead about an inch square, and just before it begins to harden introduce it into the mouth upon the forefinger, pressing it into gentle contact with a portion of the plate and about one-half of the clasp. It must be held there for three or four minutes, until it is sufficiently hard to break with a sharp fracture; this point you can determine by examining the plaster left in your bowl. The plaster must then be withdrawn. Sometimes plate, clasp, and plaster will be brought away together; or the plaster and clasp together, leaving the plate; or the plaster will separate, leaving both clasp and plate in the mouth. Should the plaster by any accident break, it can readily be united at the point of the fracture, without in the least altering its shape—one great advantage over wax. If the plaster adheres to the plate on withdrawal from the mouth, it must then be carefully detached, the plate replaced, and the same process repeated for the second clasp; or possibly the impressions for both clasps can be taken at once.

Several precautions are necessary. If the clasp bind too tightly around the tooth its ends will when removed spring together; and thus it will not exactly fill the original impression made in the plaster. If the part of the clasp which you design to cover with plaster be so regular in shape as to make its adjustment when out of the mouth uncertain, mark it with a file or a small point of solder; this will be copied in the plaster, and remove all doubt as to its definite position. If the plaster be extended over some part of the edge of the plate, it will, in the absence of any marked irregularities of surface, give a better guide for its readaptation. Lastly, if the plaster cover too much of the clasp tooth, it will be more liable to break on being withdrawn.

Take now the clasps, place them each in their separate impressions in the pieces of plaster, securing them if necessary by a small

piece of softened wax. Place one end of your plate in its corresponding bed in one of the plaster pieces. If proper care has been used, both clasp and plate will fit into the plaster with unerring accuracy, and, of course, hold the precise relation as when in the mouth. While in this position cover the clasp and the under surface of the plate with fresh plaster, or plaster and sand or asbestos; when this has hardened remove the first plaster, just as in other cases you would remove the wax, preparatory to soldering.

The methods of Drs. Fogle and Noble may be thought too tedious for cases where the shape and position of the teeth are such that a wax impression will accurately copy them; but in the great majority of cases it will be found essential to accurate adjustment to resort to one or other of them. Sealing-wax or shellac may also be used to retain the clasps in position until they are soldered to the plate.

If the clasp stands off from the tooth on its coronal edge, the food is apt to pack into the wedge-shaped space and loosen it, or even change its shape; if on the edge near the gum, it gives lodgment to the food and mucous secretions, to the injury of the tooth. Dr. Spalding recommends, as a preventive against such lodgment, to use in all cases thick, narrow clasps; to attach them by two or more standards (Fig. 919), if the clasp is long; to put them well up on long teeth, and on short teeth to cut away the plate. In this way most of the neck is exposed to the cleansing action of the tongue.

FIG. 919.

The close adaptation of the clasp to the surface of the tooth is too often neglected. It is commonly done with round pliers, making trial from time to time upon the tooth of the model. This is an uncertain method in any case, and in many utterly worthless. Prof. Austen advised always to take a separate plaster impression of the teeth to be clasped; for which purpose a small partial impression cup is used (Figs. 813 and 814). Let the plaster get quite hard; then slightly open the impression; withdraw it and close up the fissure. Make from this either a plaster or a fusible-metal tooth; if the former, harden it with soluble glass. With round pliers and a hammer clasps can be fitted with great exactness to such a metallic tooth. Extreme accuracy of fit may most easily be obtained when the countour of the tooth is irregular by the following method: burnish down to the tooth a

strip of very thin platina; then on the outside of this strip lay pieces of gold (of the fineness suitable for clasps), with borax, and flow them with the blowpipe.

A common error in soldering clasps is to make their union to the plates too wide. Clasps are often called springs, but if soldered through nearly their whole length they become rigid stays, devoid of elasticity. There should always be a proportion between the size of the clasp and the width of its attachment; in no case should it exceed three-sixteenths of an inch, and one-eighth of an inch is ample for most cases. When practicable the two arms of a clasp should be of equal length; but in short clasps it is sometimes preferable to throw all the elasticity into a single arm. A single attachment is better than two, as it gives more play to the arms of the clasp in the slight unavoidable motions of the plate. Again, in shaping the plate, cut it well off from the tooth, allowing a tapering tongue to extend up to the clasp for its attachment. In clasp pieces and in all partial pieces remember that the plate should come in contact with teeth it approaches, or else stand as far off as the case will permit; the narrow band of gum so often left between plate and teeth is liable to irritation by compression between the two; this is productive of more annoyance and injury than the direct contact of the plate against the tooth.

Partial Clasps or Stays.—These differ from clasps in the absence of elastic arms grasping the tooth. Taking a short, rounded prism (triangular in case of bicuspids, in molars quadrangular) as the "type" of a clasp tooth, the clasp proper must grasp a side and two angles or two sides and three angles. If it lies against two sides and one angle, or if two opposite sides are so inclined (in the line of the clasp) that it will not take hold, then it becomes merely a stay.

Stays demand for serviceable action a *point d'appui;* hence they must be in pairs—lying either against the two teeth bounding an interdental space, or against teeth on opposite sides of the mouth. They have great value in all partial cases where there are no isolated teeth suitable for clasps. Their function is to give stability to the plate by preventing lateral motion. When the bicuspids or molars have inclined or bulging inner surfaces the stays hold the piece after the manner of a clasp, the elastic force being given by the plate. This result can only be obtained, however, by a very carefully taken plaster impression when a vulcanite plate is made, or in case of gold plate by getting the exact relation of the parts by Dr. Noble's method. It is a mistake to attempt forcible retention of a plate by the lateral thrust of stays; any such pressure

causes the teeth to yield, and then the stays can only act as in the cases first given.

It will be observed that when the stay on each side is double, as in Fig. 921, it not only prevents lateral motion, but the points between the teeth prevent backward motion. The stability given in this manner by stays, taken with an exact adaptation of the plate, is far more trustworthy than that given by any form of vacuum cavity.

In connection with clasps we shall briefly notice two methods occasionally practiced for the retention of plates. First, by the pressure of wood against the tooth. This method was formerly much used when human or ivory teeth were set on bone. Stays were

FIG. 920.

FIG. 921.

carved in bone (see Fig. 921); or metallic stays or clasps were riveted, or grooves and cavities were cut, holding slips of some hard wood which pressed against the teeth. This method was applied by Dr. Stokes to metallic plates—soldering gold tubes to the plate near the teeth so that the end of the inserted wooden pivot, slightly projecting, pressed on each side of the tooth selected.

Secondly, by drilling into one or two sound roots of incisors, canines, or bicuspids a short canal, and lining it with a gold tube. Corresponding pins soldered to the plate keep it in place much as stays do; if the roots permit deep canals they may retain it with considerable force. Such a pin may be used in combination with a clasp or stay. Directions given in chapter on crown and bridge-work easily explain how to prepare and attach such pins. In some cases it may be desirable to use such a pin in place of a clasp or stay, but the plate must cover enough mucous surface to give stability. We question the propriety of subjecting the roots of two incisors to the strain of five or six teeth on a plate of this kind.

When the teeth have recently been extracted and it is designed to construct an artificial denture before much change has occurred from absorption, the front portion of the plate should terminate within the outer border of the alveolar ridge, and the edge be scalloped to correspond with the festooned surface of the gum over the cavities from which the natural teeth have been removed.

Size and Outline Form of Special Cases.—It is impossible to enumerate all varieties of clasp pieces, nor could we delineate under each variety any one form as absolutely best for all its sub-varieties. The more philosophical course is to find if possible what principles, mechanical and physiological, determine the best form in any case, and to illustrate by a few examples the application of these principles.

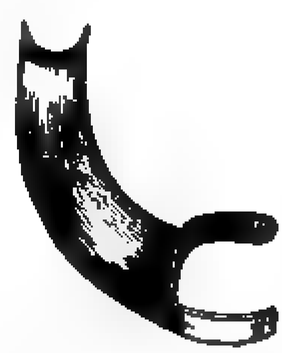
Upper Incisors.—The plate must not cover the front of the alveolus, so that on front or side views of the mouth its presence can be detected. This rule applies also to canines and front edges of bicuspids. The model at these points should be scraped, so that the corresponding die shall give a shape which will sink into the gum. The plate must also be filed to a thin edge before grinding the tooth. With these precautions a tooth or block may have the support of the plate under the centre of its base. Otherwise it becomes necessary to cut the plate along the line of the backings; and this is in some cases the best plan. Incisor teeth, if firmly bedded in the gum, may trust for stability to their hold in the standards, provided they have been properly fitted and soldered.

The size and shape of plate between teeth and clasps will depend upon the number of incisors, position of clasps, presence or absence of other teeth, and upon peculiarities of the mouth or of the patient. For the application of the principles already given to these several conditions we shall select a few particular cases.

One Incisor.—A central or lateral should not be attached to a first molar on the same side by a plate clasped as in Fig. 923

FIG. 922.

FIG. 923.



without an additional clasp or partial stay around one of the bicuspids, as in Fig. 922, in order that the leverage between the clasped and supporting tooth or teeth may be lessened. It is also desirable to have the plate extend some distance back of the tooth around which the clasp passes. When three or more natural teeth intervene between

the clasp and artificial teeth the latter form is preferable, because there is no possibility of irritating the teeth by the plate or by mucous deposits. It will be noticed that the curve of the plate is opposite that of the dental arch, thus giving proximity to the teeth only where it is unavoidable. A lateral incisor, cuspid, or bicuspid may be applied in the same way; and if the second bicuspid or first molar is unfit, from its shape and from decay, to be clasped, the plate may be extended to the second molar, or it may be even carried across the mouth and clasped to a plate on the opposite side; but these modifications are suggested only in cases of necessity. Such plates may be made very narrow if strength is given by increased thickness; but too narrow plates are open to the objection of allowing the attached tooth to bed itself too deeply under the pressure of mastication. When the form in Fig. 922 is adopted it is usual to direct soldering a wire or band along the festooned edge to give strength. A much better plan is to gain strength by thickness of plate, and to chamfer the plate along this edge. The thin edge protects the gum equally well, does not wear the teeth more than the thick one, and has the decided advantage of giving no space for lodgment of food.

This plate will permit attachment of clasp to the molar and to either of the bicuspids, accordingly as one or other of these may be best for clasping. Decision in this case is based on principles which apply to many other cases. Supposing the three teeth well shaped and sound, the molar is firmly implanted by its trifid root, and permits complete encircling with the clasp; but it is further from the incisor; hence there is more strain upon tooth and clasp. With the clasp to the second bicuspid, the plate having the same length as before, we have the best possible application of its retentive power; it cannot, however, pass around the outside or front angle of either bicuspid, consequently the clasp does not have so firm a hold on the tooth. The same remarks apply with even more force to the first bicuspid. There will usually be some modifying circumstances to determine in this class of cases choice of the clasp tooth.

Two or Four Incisors.—Two incisors may be attached to a plate shaped as for one (Fig. 922), with the addition of a second clasp, or partial stay, when the teeth will not permit of a full clasp. But much the best practice is to select the second tooth on the opposite side. Fig. 924 gives the form when it is decided to run the plate up to the intervening teeth. Fig. 925 represents the second form, which would be better suited if the plate was made larger than is shown in the figure, so as to cover more of the roof of the mouth.

With four incisors and clasps on second bicuspids, the first form is best, because only two teeth lie between the incisors and clasp; and it is better to carry the plate up to the teeth than to expose so small a portion of gum. For four teeth the plate should be rather wider than for two.

In these cases a closely-fitting plate assists so much in its own retention that bicuspid stays will often suffice to retain them, or a clasp on one side and a stay on the other. When the adhesion of the plate to

FIG. 924. FIG. 925.

the gum is thus partly relied upon it is not necessary to make the plate for four incisors larger than in Fig. 924.

When the four incisors and the cuspids are to be replaced the construction of the plate (Fig. 924) is upon precisely the same principle as the preceding, the only difference being that the plate should be rather larger and extend further back than the clasped teeth. When the teeth on one side of the mouth are too much decayed, or are incapable of affording a secure attachment, or are missing, even this number of teeth may be held by a double clasp on one side of the mouth and a stay on the other. But the plate should be extended half or three-fourths of an inch back of the tooth to which it is clasped. If this precaution is neglected, the piece from its weight may act as a lever upon the tooth and loosen it or cause periostitis. It sometimes happens that a piece made originally with clasps on both sides of the mouth loses the benefit of one clasp from the loss of the tooth; and yet the patient retains it in place as well as before. The piece is then in part retained by the fit of the plate to the gum; from which

FIG. 926.

we learn that if only one clasp or, what is better, a double clasp can be attached to a plate with from four to six teeth, it is advisable to cover rather more of the surface of the mouth. In this combination the clasp and stay give steadiness, and the close fit of the plate to the gum gives adhesion.

Upper Bicuspids.—One or both bicuspids on one side are often attached to a plate about the size of a half dollar, clasped to the bicuspid or molar behind. But such pieces are not of much service in mastication. It is better practice to leave such a space unfilled than endanger the durability of a good tooth by clasping it. If there is a bicuspid space on either side the plate crosses the mouth. Fig. 927 represents such a plate clasped to the first molars and fitted, as

Fig. 927.

Fig. 928.

is very commonly done, closely to the incisors. But in this and all other cases where the four or six front teeth remain, if the plate does not fit closely to the palatal necks of the natural teeth, it is decidedly better to leave as large a space between the plate and the teeth as possible. The strength of the plate is preserved by giving less curve to the back edge, or by doubling the plate in the middle. The design of this form is to leave uncovered as much of the roof of the mouth as is possible.

An important point is gained by having the plate fit closely to the teeth and mucous membrane immediately back of the natural front teeth, and also by having the edge of the plate made thin. The articulation of the dental letters (the mutes T, D, Th, the nasal N and the liquid L) is thickened by a plate which is left thick at such a part, or not well adapted to the mucous membrane and the teeth.

When the loss of bicuspids is accompanied by that of the six front teeth, and the first molars alone remain, a good form of plate is shown in Fig. 926. The backward extension of the plate, curving partly over the alveolus, is designed to prevent the weight of

the piece from acting injuriously on the molars and to assist their retentive power. If the second molars are also in the mouth, the extended plate must be differently shaped.* If the molars are well shaped and firm the plate may be narrower than here represented, being careful to make it thicker also. But if the presence of adjacent molars prevents the use of complete clasps, or if their form renders stays necessary instead of clasps, the plate may be rather wider. Be careful, however, not to cover the hard floor of the palate, or to attempt giving, by a cross band at the back of the plate, the stiffness which is best gained by thickness of metal.

Plates of this class are kept in place as much by the adhesion of contact with the gum as by the clasps. In many cases the force of adhesion is such that the lateral support of stays is quite as effectual as clasps. Hence, after a clasp piece of this kind has been worn for some time and become perfectly set to the mouth, it may be advisable to shorten the clasps into stays; indeed, it is better practice, in all cases, to anticipate this ultimate fit of these plates and make stays at first instead of clasps. This applies with still more force to the loss of twelve teeth, the second molars remaining, which should in no case be clasped; stays may very properly be used to prevent lateral or backward motion of the plate. The presence of these second molars, by giving lateral steadiness to the plate, prevents all necessity for covering the hard palate, and makes a vacuum cavity wholly uncalled for. A solitary molar should never be clasped, nor should it be allowed to remain in the mouth.

Alternate Spaces.—It remains to consider the forms of plates for vacancies alternating with natural teeth. The forms given for four incisors will answer for all alternating vacancies anterior to the second bicuspids, remembering to make the plate wider in proportion to the number of teeth, and thicker in proportion as it is made narrow; also, that a first bicuspid may in many of these cases be clasped with better effect than a second or than the first molar. Fig. 929 is a good type for cases where the vacancies include the bicuspids; notice in this cut the backward extension of the plate. Where the natural teeth are in groups of two, it is best to carry the plate close up; if as many as three or four are together, the plate may be cut away, especially if they are incisors. Fig. 930 represents an exceptional case, in which two laterals and two left bicus-

* The festooned shape of this and similar cuts is designed to mark the number and position of the artificial teeth. The forms of the teeth are omitted as having nothing to do with the subject of this chapter. The plates on the models are taken from the valuable work of Prof. Richardson.

pids are attached by clasping to the right first bicuspid and molar. The left molars are supposed to be loose, or sockets much absorbed, or from some other cause forbidding clasps or stays. In this case the undue strain on the clasp teeth will ultimately cause their loss. Whenever an unavoidable strain of this kind is thrown upon a tooth a clasp may be used in preference to covering the palate, provided the patient is content, for the sake of the firmness which it gives, to risk the loss of the tooth. Teeth are more firmly retained by clasps than by atmospheric pressure, and this, with many patients, outweighs all considerations of injury to the other teeth.

Partial pieces with alternating spaces do not acquire that adhesion by contact found in cases where the lost teeth lie together. The interrupted margin between the teeth so readily admits air

FIG. 929. FIG. 930.

under the plate on the slightest motion that the atmospheric pressure is imperfectly applied. Hence there is continued demand for the retentive power of the clasps. The vacuum cavity does not correct this difficulty or supply the place of clasps, since, as will be explained in the next section, the vacuum acts on soft membrane and has necessarily a temporary force.

When the six or eight front teeth remain, a plate holding bicuspids and molars cannot be retained by clasps. In the first place the cuspids could not be clasped, nor would it be proper even to carry stays against them. In the latter case the weight and leverage of the piece would be too great for the slight clasp that a first bicuspid permits; but two stays, with the points passing as far to the front of the bicuspids as the cuspids allow, would tend to prevent the slipping of the plate backward.

Lower Partial Pieces.—These do not properly come under the head of clasp work. In replacing one or more incisors lost by accident or calcic deposits half-clasps may be applied to the bicuspids.

For such cases the best style of work, beyond all question, is a vulcanite plate, made on a model from a plaster impression. Fitting with great accuracy the inner surfaces of the bicuspids, it is firmly held without injury to the retaining teeth. Partial pieces filling bicuspid and molar vacancies should not clasp cuspids or bicuspids; the position of remaining molars seldom permits clasping; even stays cannot always be applied. Artificial crowns may be inserted to support a clasped plate and gold crowns may be attached to roots and badly decayed teeth to support clasped plates, and thus save more valuable teeth from the strain and wear of clasps.

In chapter fourth, on Preparatory Treatment of the Mouth, the question of extracting molar or bicuspid teeth which might otherwise be used for clasping is considered. The importance of permanence of the work outweighs any temporary advantage resulting from clasping one or two such teeth. In chapter third, and in the section on Retention by Clasps, are many remarks which it is unnecessary to repeat, but which are important for the full understanding of the details of construction given in this section.

PLATES RETAINED BY ATMOSPHERIC PRESSURE.

Of the two methods of retaining a dental appliance already considered, the first, by springs, is suited only to entire dentures; the second, by clasps, is adapted only to partial cases. The principle of retention now to be considered is applicable to both; where practicable it is the most perfect way of retaining a set of artificial teeth. If the pressure of the atmosphere could be removed from the mucous side of a plate, allowing its full force to be exerted upon the lingual surface, the smallest plates would adhere with a force of four pounds, the largest forty. But, for reasons to be given, plates seldom have one-fourth of this resistance to displacement. There are two methods in present use for securing the service of atmospheric pressure. One is by close adaptation of the plate; the other by construction of a cavity of definite form. Both act by the more or less perfect exclusion of air from between the plate and the mouth. The first will be considered as the Adhesion of Contact; the second as the power of the Vacuum Cavity. Before describing the separate application of these to dental plates, a few remarks are necessary in addition to what has already been said in the last section of the third chapter, in exposition of the general principles of atmospheric pressure.

The surfaces of two pieces of highly polished ground glass, if

pressed together, will adhere firmly; so much so, sometimes, as to resist every attempt at separation. Surfaces less smooth and close-grained will also adhere with great tenacity if their pores or irregularities are filled by wetting with water. If both surfaces are rigid they may be made to slide upon each other, but will resist a force of five to fifteen pounds for every square inch if applied at right angles to the surface; if one surface is soft and pliant it becomes difficult to keep it in contact around the edges. Traction upon the centre, as in the case of a disk of wet leather upon a flat stone, will draw in the edges and create a vacuum in the centre. It might be supposed that in this vacuum space lies the power that raises the stone; whereas it lessens the power by reducing the area of stone in contact with the leather, even if the vacuum is perfect. Still, if the entire circumference is in contact no air enters the cavity except what passes through the porous leather, and for a time the lifting-power of the disk is sufficient to raise the stone. If traction be made upon the disk anywhere but in the centre the flexible edge will be raised; air enters between the surfaces and counteracts that pressure on the under side of the stone which was the lifting force.

Hence between two surfaces adhering by simple contact, one of which is soft and pliant, adhesion is not so persistent as where both are rigid, because of the liability to separation around the edges admitting air between the surfaces. Applying this to dental plates we may understand their liability to become detached by a degree of motion which separates them from the gum at any one point around the edge. We learn also that so long as absolute contact is maintained we have the most perfect exclusion of air practicable; hence no force of adhesion in a limited vacuum cavity (the perfect exhaustion of which is impossible) is comparable to the adhesion of the entire surface of the plate, provided this is made as perfect as possible by accurate workmanship and is not weakened by the admission of air around the edges.

If we exhaust the air from the barrel of a key and apply the lip, it will be drawn in and held with a force sufficient to support the weight of the key for some time. This simple experiment will prove, on examination, very instructive. The mucous and submucous tissues are pressed into the key because the fluids pervading these parts, being under pressure in every other direction, tend toward the point from which the pressure is wholly or partially removed. The extent to which the lip is drawn into the key will depend upon two conditions: *First*, the softness and mobility of the tissue; *secondly*, the shape of the edge of the orifice. If in addition to these two points we inquire, *thirdly*, why the key after a time drops off,

we shall, from this simple illustration, have fully explained the rationale of the vacuum cavity, as applied for the retention of a piece of dental mechanism.

First: the extent to which or rapidity with which a partial vacuum becomes filled up by any yielding tissue with which it is brought in contact depends upon the mobility of its structure. We say partial vacuum, because the process of mechanical exhaustion can never produce a perfect vacuum. If the water which gives softness to mucous tissues was perfectly free to move, the cavity would be instantly filled, however deep. Parts as mobile as the tongue and lips yield readily to this fluid pressure; but the mucous membrane of the alveolar ridge and palate, being more or less tied down to the bone, fills the cavity more slowly; if too deep it will not fill it at all, except by hypertrophy. Reverting to the experiment of the key: if violent suction is made a purple spot is left upon the lip; the mucous tissues being prevented by their structure from filling the vacuum, the fluids still feel the impulse of atmospheric pressure; the blood, thus impelled with a force which the thin capillary walls cannot resist, is extravasated, as takes place also in the application of "dry cups." Hence, where a dental-plate cavity is so deep that the tissues cannot fill it, if the degree of exhaustion is such as still to draw upon the surface, the tissues are in danger of being ruptured. Such a source of irritation will in many persons develop morbid action and should forbid the use of deep cavities in any plate.

Secondly: The shape of the edge modifies the rapidity with which the cavity fills. If the edge of a cupping glass is rounded the skin glides under it and is drawn from the adjoining parts into the glass; but if the glass is ground so as to present a sharp edge on the inside, this beds itself in the surface and prevents so much of the adjacent skin from being drawn in. It rises to a less height in the cup, and the remaining force of the vacuum is spent upon the capillary vessels, which are ruptured. Hence we learn that sharp-edged cavities fill less rapidly, but act with more power upon the tissues; they are consequently more apt to excite disease if the cavity has sufficient depth to allow continued action.

Thirdly: As to the cause of the final dropping off of the key: water and all the moist tissues of the body contain atmospheric air which they yield up under a vacuum. Hence a mucous membrane, although at first drawn strongly into a cavity, will make the vacuum less complete by giving out the air contained in its tissue and in the blood constantly circulating through it. The adhesion of a vacuum, therefore, over mucous membranes requires renewal

by occasional suction, since the blood is constantly circulating through the surface and supplies air to the cavity. Mucous membranes have also the property of *absorbing* air, as is seen in the lining of the bronchial cells constantly and in the power of the mucous membrane of the intestines to absorb the gases there generated. This property acts an important part in absorbing small quantities of air unavoidably caught between the plate and the mouth; thus partly explaining the well-known fact that plates adhering by simple contact become tighter after being worn awhile.

Thus the double action of mucous membrane, absorbing minute portions of air pressed against it, and giving out its contained air to a vacuum, favors the retention of simple contact, whilst it acts against the efficacy of the vacuum. In either case it prevents the full force of pressure theoretically possible. The practical inference from the lesson of the key is that the Vacuum Cavity acts well at first, and may be useful for the temporary purpose of retaining a plate until the changes of which the mouth is capable adapt it more perfectly to the plate; but for permanent adhesion the only reliable application of the atmospheric-pressure principle is the Adhesion of Contact, which is fully developed only when the contact of the plate is complete. A vacuum cavity, acting as such, gradually draws the gum into it and finally fills it by a more or less permanent enlargement; when thus filled the plate is retained solely by the adhesion of contact. When a cavity intended to hold up a plate leaves no prominence or mark in the mouth, it unmistakably proves that it is exerting no force; so far from aiding in the retention of the plate it diminishes the force of adhesion by the presence of air, and has no compensating advantage except in removing pressure from a hard palate membrane. There are, however, other and better ways of obtaining an air space, as elsewhere explained, without the presence of a cavity, which marks the failure of its original purpose.

ADHESION OF CONTACT.

Full plates, which are designed to adhere by force of contact, differ from those retained by spiral springs in that the former are larger than the latter, covering more of the palate, so as to give a larger surface for the pressure of the atmosphere. They may cover the whole of the outer surface of the alveolar ridge and a considerable portion of the roof of the mouth; but should not go as far back nor run so high up as some dentists are in the habit of extending them. If allowed to cover those parts of the bone where the cheek muscles on the outside of the ridge or the palate muscles at the

back of mouth are inserted, the gums will be chafed or ulcerated, the patient nauseated, and the piece rendered unstable by the action of the muscle. It is not always necessary to employ a very wide plate to give secure retention, for a comparatively narrow one will often adhere with very great tenacity to the gums. But such a plate is more liable to be bent and lose its perfect adaptation to the parts than a wide one, unless made thicker in proportion as it is narrower. As it is never necessary to make an upper plate so narrow as a lower one, there can be no difficulty in giving the requisite strength, either by increasing the thickness throughout or by doubling the anterior half.

Fig. 931.

The diagram (Fig. 931) represents half-section outlines of six modifications of form in the posterior margin of the plate, where it is proposed to overcome the difficulties incident to a hard palatine membrane by cutting out the plate. The line P, curving forward from a little behind the termination of the top of the ridge (dotted line), is the extreme limit of any plate not complicated with cleft palate. The curve *a* or *a′* will give surface sufficient for the retention of most plates, except in small arches. This form is more agreeable to the patient than the first, and is less apt to produce nausea; it removes the plate from all action of the palate muscles, and lessens the liability to dislodgment often caused by the forcible action of the tongue against the back of the palate in certain efforts of deglutition. The curve *b* or *b′* may often be used solely to avoid unnecessary covering of the palate. In mouths of average size and having moderate and regular softness such shape will prove quite as firm as one following the line P. But these lines are more frequently to be followed, for the same reason that we take the curve *c* or *c′*, to keep the plate off the hard central ridge. When this ridge is narrow we give greatest width to the plate by following the curves on the side R of the diagram; but if the surface is broad the space must be widened, as on the side L, and the plate made thicker.

This method of relieving the central bearing of plates gives them great steadiness on the ridge, and has an advantage over other methods in having no band or ridge of plate pressing along the line P—a point very often as hard as any other part of the palate. It is

advisable in those cases where a vacuum cavity has been tried with unsatisfactory results to cut out the cavity and part behind it, and thus try the effect of a plate following curve *b* or *c*.

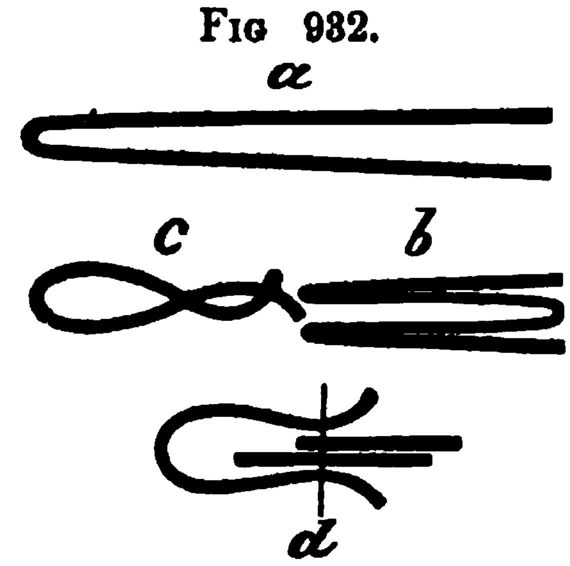
There are other methods of taking off the central bearing of plates. When the ridge is soft a wax impression does this by compressing the gum. Models from plaster impressions are scraped on the ridge for the same purpose; but this is not so good a plan, as it is difficult to do it uniformly. A much better expedient is to brush some thin plaster over the central part of the model, being careful to mark the line of the back edge of the plate, and put no plaster there; this layer must not be thicker than a card, and should have no abrupt edges. A thin layer of wax may be added in the same manner to plaster models before moulding in sand to obtain the die for swaged metal plates. In deep arches the shrinkage of the zinc die accomplishes the same object; if the model is carefully scraped along the back edge of the plate this part will fit closely, while the central portions will stand off; this is far better than the attempt to adjust the edge with pliers.

In adapting atmospheric-pressure plates the form and fit of the alveolar margin must be considered. Close adaptation of this edge is by no means so essential to firm retention of a full upper piece as in the posterior margin; for the reason that, in most cases, the loose mucous folds which lie against the plate prevent the access of air. But closeness of fit is very desirable for other reasons: to prevent lateral motion; to avoid unnecessary fullness; to prevent irritation of the soft parts by projecting edges of metal. The form of the alveolar edge is not essential to adhesion, provided it rises high enough to give steadiness to the plate. Æsthetic considerations, however, often compel us to run the plates up as high as the muscular attachments will permit, either for the support of an artificial gum or to restore sunken features. In both jaws, especially the lower, the effort to get the deepest possible edge often gives instability by subjecting the piece to the action of the facial and lingual muscles. In any case of doubt make the plate too shallow rather than too deep; especially when the edge is turned over, which makes it impossible to take off any excess without spoiling the plate.

Full lower plates are held by adhesion of contact; but in these the weight of the piece increases the adhesion. The surface is so small that every part of such plates should fit the gum with accuracy. The simpler rule for the form of lower plates is to extend them as far on the inner and outer edges as the muscular attachments will permit. The outer and inner edges are often rounded by soldering a gold wire after determining the exact outline.

Thickness of edge is also given by doubling the plate necessary for the strength of narrow plates. The second plate is to be swaged precisely as the first; then, after partial trimming, the two plates are swaged together over a new die. One should be wider than the other on the outer or inner edge to give a place for the solder; the borax cream should be free from granules, and the blowpipe flame directed on the edge opposite the solder. A simple and convenient clamp for binding plates together or holding rims while being soldered is made of iron (or nickel) wire (Fig. 932). *a*, the first bend; *b*, the second bend; *c*, a side view of the same; *d*, side view of clamp, open and grasping two pieces of plate. The curves should be so adjusted that the points of contact with the plates will be just opposite, else clamp or plates are liable to change position.

FIG 932.



Partial pieces may also be retained by closeness of adaptation; but there are two elements of instability which usually will prevent them from having the security of full sets or of partial clasp pieces—lateral movement and extent of margin, admitting air on slightest motion. All such pieces should, if possible, have two stays, one on each side of the mouth, to prevent lateral motion; they should cover an extent of surface proportioned to the number of teeth; the edges of the plate should fit with great accuracy. If the exact outline of the plate is determined on, a good plan is to paint the model with a coat of thin plaster, keeping one-eighth inch inside the margin and laying an extra coating over very hard places; this causes the edge to sink slightly into the gum; yet if carefully done it will not change the general contour of the surface. Partial plates, holding the eight, ten, or twelve anterior teeth, if assisted by stays against the remaining molars, are nearly or quite as firm as full plates. But in either partial or full pieces, whenever the plate has to be cut off for setting the six front teeth directly on the gum, this dentated margin is more apt to admit air than the upturned rim, which has the folds of the lip lying against it. Partial lower plates are unstable, not from any admission of air, but because of the small extent of surface, inadequate to the pressure of mastication.

Plates for partial dentures to be held in place by clasps or bands are generally made narrow, and the posterior line or edge within the depression of the rugæ, so as to be out of the way of the tongue, but such plates must not be made too small, or they will cause pain

by being forced into the mucous membrane. Partial lower plates for artificial bicuspids and molars, the six natural anterior teeth remaining in the mouth, should extend up on the lingual surfaces of the natural teeth to prevent the too great pressure of the plate against the inner surface of the alveolar ridge, and also to give greater strength by the increased width and form of the plate back of the natural teeth, which would otherwise have to be made very narrow and thick. The lower inner edge of full and partial lower plates should extend so far down as to be out of the way of the tongue. Carrying the edge of such a plate over the projecting surface of the ridge, which is generally present into the receding underspace, will prevent the tip of the tongue from getting under it; at the same time the plate should not extend so far down as to interfere with the frænum of the tongue.

A tongue or catch may be swaged as part of a partial lower plate to extend slightly over the angle of the crown of a posterior natural tooth, such as a molar or bicuspid, and catch on the grinding surface, and thus prevent a partial lower denture from pressing painfully on the gum. This tongue or catch should be adapted to the grinding surface of the natural tooth at a point where it will not interfere to any great degree with the occlusion of the natural teeth. Partial stays fitting as far as possible into the interspaces between such natural front teeth as remain in the mouth, will prevent partial lower dentures containing artificial bicuspids and molars from sliding backward, as all such dentures have a tendency to do. Such stays will also prevent the plate from being raised from its place by the cheeks and muscles.

THE VACUUM CAVITY.

In some mouths the base plate of a full upper piece adheres from the beginning with great firmness. When the gum is moderately and regularly soft, the palatine arch deep, and the mouth of average size, want of adherence, on trial of the plate, is positive evidence of defect in construction. But very hard or very small or very shallow mouths usually require time for the perfect adaptation of the best made plates. Dr. Dwinelle thus explains the temporary failure of a simple atmospheric pressure plate to fit firmly when first inserted. When the plate is applied and an effort made to exhaust the air the gums are drawn down so as to meet it along the line and behind the edge of the plate, thus resisting every effort made from without to withdraw the air from the central part of the plate; so that the pressure of the atmosphere is exerted upon only

a small breadth of surface along its edge, where the adhesion is constantly liable to be disturbed in mastication.

With the view of obviating this difficulty the idea of constructing a plate with a cavity suggested itself to the author as early as 1835, and was mentioned at the time to several of his professional brethren. The construction of the chamber then devised was found objectionable and he abandoned its use; and it was not until the early part of 1848, when he had the opportunity of seeing a cavity plate upon a plan contrived by Dr. J. A. Cleaveland two or three years previously, that he was again induced to construct a base plate of this kind. Dr. Dwinelle made a cavity plate with an external opening and valve for exhausting the air in the winter of 1845; and in the summer of 1847 or 1848 Dr. Jabial Parmly exhibited to the author a plate with a simple cavity struck into it by swaging. Some months after he heard for the first time of a cavity plate patented by Mr. Gilbert, of New Haven. The cavity now generally employed

FIG. 933. FIG. 934.

is formed on the median line, either far back for full plates (Fig. 933), or immediately behind the alveolar ridge for some partial plates. Dr. Flagg adds two lateral cavities on the slope of the palate with a view to prevent the plate from rocking and to give it increased stability. Dr. Levett's lateral cavities are placed directly upon the ridge (Fig. 934). With this brief history of cavity plates we shall proceed to give a concise description of the manner of constructing them. The following is the mode of construction of Dr. Cleaveland's cavity plate, which, for reasons given below, is now seldom used.

A metallic die and counter-die having been obtained, a plate is swaged, covering the entire alveolar border and extending back as far as the line P (Fig. 931). This done, it is placed in the mouth, and if found to be accurately adapted to the parts it is removed; a half-round gold wire about the size of a common knitting needle is then soldered to the lingual side of the plate, enclosing a space shaped somewhat as is shown in Fig. 933, varying in size and form

with the differences in shape and size of the plate and alveolar ridge. The part within the wire is next cut out with punch-forceps or saw and the plate placed on the model; a piece of wax about a tenth or twelfth part of an inch in thickness, having a circumference one-fourth greater than the hole in the plate, is then placed over the opening, extending a short distance beyond the wire on every side. The wax at the outside is brought to a thin edge and is also made thinner in the centre than where it covers the wire surrounding the opening in the plate. From this model with plate and wax upon it, die and counter-die are obtained with which to swage a thin plate of gold, large enough to cover the wax; its edge is chamfered off, and it is then soldered to its place on the plate, where it may be secured during soldering either by iron wire clamps or by gold rivets. A sectional view of the cavity is represented in Fig. 935 A. The Cleaveland cavity causes the plate to adhere with great tenacity, as from its shape it is impossible for the mucous membrane

FIG. 935.

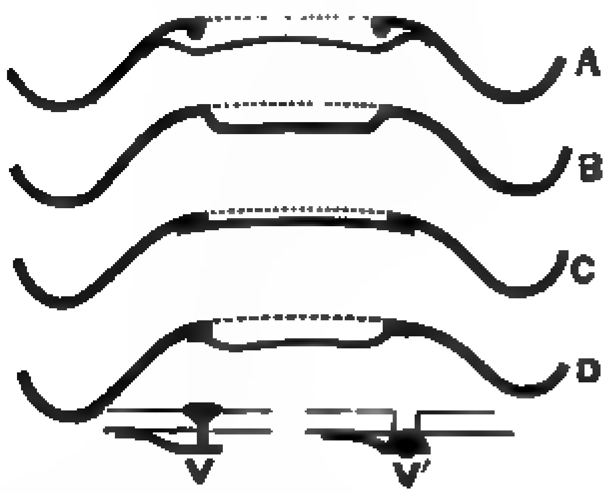


FIG 936.

entirely to fill it; the traction of this cavity is constant. A serious objection to its use is the great irritation it excites in the mucous membrane in the majority of cases.

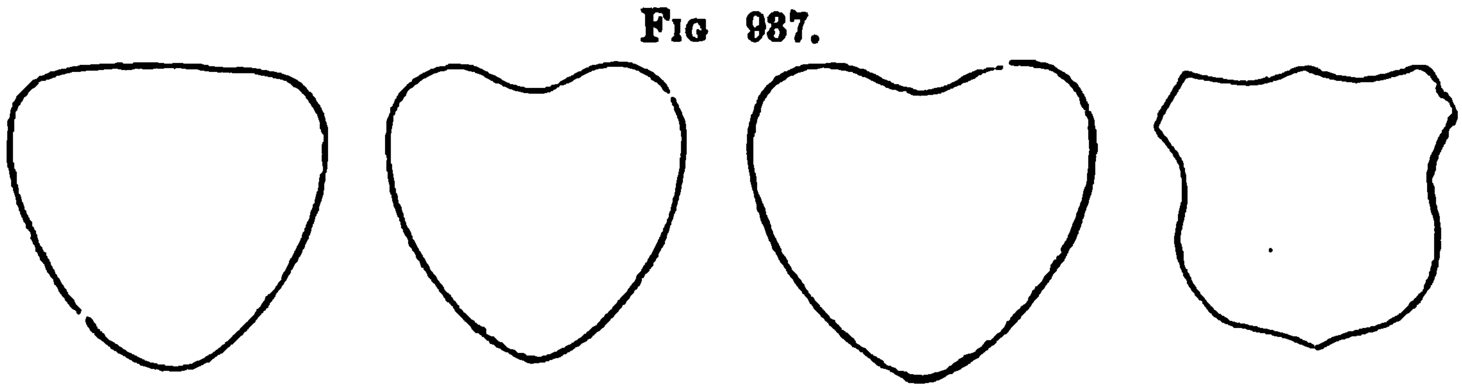
The simpler cavity plate used by Dr. Jahial Parmly, of New York, and patented by Mr. Gilbert, of New Haven, may be formed with nearly as much ease as a plain plate. Fig. 935 B represents a sectional view of this description of plate. If it is desired to have lateral cavities, three pieces of wax or metallic forms are placed on the plaster model—one in the centre, as already described, and one on the slope of the alveolar ridge on each side. When it is desirable to make a cavity with sharply defined border, D, a second plate a little larger than the projection should be swaged over the base plate. From the base plate the projection is to be cut out and the smaller plate soldered over the opening. For hard mouths the

thickness of the main plate will give sufficient depth of cavity, C; in this case no projection is to be placed on the model.

Should the usual method of exhausting air from these cavities be thought insufficient, the valve of Dr. Dwinelle (Fig. 935 V) may be inserted in the plate covering the cavity. The conical portion is neatly fitted by grinding; the stem is soldered to a spring on the palatine surface. A valve of easier construction is given at V′; a small rubber pad acts, by the spring, upon the outside of the hole. The size of valves and thickness of plate are exaggerated, the better to illustrate the details of construction. By means of either of these valves a vacuum may be created, which will draw with great force upon the membrane over the cavity.

The forms B and D, Fig. 935, necessitate a prominence in the die which is variously formed. When the die is made by sand moulding, a corresponding one, formed of wax, lead, tin, or plaster, is put on the model; a die made by dipping or pouring or by the fusible metal process requires plaster. Dies made by pouring into the impression require the cavity to be cut in the impression itself. A variety of shapes in tin and alloy are furnished by the depots, chiefly for vulcanite work; but they may be used also for the sand moulding model. Plates made by the metallo-plastic processes require plaster prominences.

FIG 937.



The size, depth, form, and position of the cavity are important considerations. In size it must be proportioned to the plate. Fig. 936 gives a fair average size and is excellent in form, except that it is unnecessarily pointed; all angles and sharp corners should be avoided, and fanciful shapes are æsthetic blunders; the form should appear to grow out of some necessity; and hence it should be modified to suit the form of plate. Shallow cavities may be larger than deep ones; partial pieces usually have a cavity larger in proportion.

Fig. 937 represents the usual forms of vacuum cavities (the shield form being objectionable on account of its sharp angles), which may be metal, such as block tin, that will not discolor the rubber; vacuum cavities made of sheet lead are objectionable on that account.

In depth the cavity must vary with the softness of the membrane. If soft it quickly fills a shallow cavity and is less liable to injury

by a deep one. Sharp-edged cavities fill less quickly than round-edged ones. They may vary in thickness from No. 14 to No. 24 gauge plate, page 867. When the cavity is designed, after a temporary retaining power, to act permanently in relieving the pressure on central hard parts, it should be very shallow. When, in very flat mouths, it is proposed to prevent lateral motion by the mucous prominence the cavity should be deeper. Extreme depth, with a view to keep up constant action, makes a most unsightly piece and injures the mouth.

As to position there would seem to be much difference of opinion, if we judge by the various points selected. We have never had but one opinion on this subject, and that is in favor of the central cavity. The cavity resists the greatest force of displacement when applied at right angles; as this force is always nearly or quite vertical, it follows that the most effective cavities are horizontal; hence they should only be on the roof of the palate and limited to its level portion. Cavities covering the rugæ or sloping walls of the palate act at disadvantage. Again, after the cavity ceases to act its secondary use in relieving pressure can be available only in this position. The very worst position for a cavity is on the ridge of either upper or lower jaw. Firm pressure on the ridge is one of the most important elements of stability in a plate. It is difficult to comprehend what compensation for the loss of this is found in the cavity.

Partial plates require, when the cavity is used, a modification of form to enable the cavity to be placed on the roof of the palate. Yet the shapes elsewhere given may be used in connection with Flagg's lateral cavities as represented by the oval in Fig. 938. If no stays can be used, as in a piece of artificial bicuspids and molars with natural incisors and canines, a central or two lateral sharp-edged cavities may be of service to prevent lateral motion. In all other partial cases stays may be used; these, combined with accurate fitting, will give as firm a piece as any form of cavity. The vacuum cavity may also be formed in the impression by adapting a form of wax to the roof of the mouth in the proper position before inserting the cup.

Dr. C. H. Land has recently suggested a vacuum cavity pattern (Fig. 939), which is claimed to be of such a form as to secure the greatest advantage from atmospheric pressure without injury to the mouth; also to serve as a relief to the hard portions of the arch by being of sufficient depth to allow for continued absorption of the alveolar ridge in the case of first sets; it is also claimed that its shape avoids interference with the organs of speech.

Dr. Joseph Spyer has devised for plastic work a thin metallic form, the surface of which is covered with minute papilliform prominences—shown in Fig. 941 magnified four diameters—which by displacement of mucus at the points of gum contact effect surface cohesion as if the denture were glued to the gums, yet cause no irritation and leave no marked indentations. Adapted for either upper or lower plates. By the aid of this device it is claimed that strong cohesion can be had with a narrow plate, and thus the sense

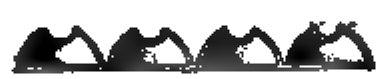
FIG. 938.

FIG. 939.

of taste be left unimpaired, and that lower plates so made are very firm. They are put up in packages containing one dozen forms size of Fig. 940, which can be cut for either upper or lower plates.

FIG. 940.

FIG. 941.



These forms are also made of gold with a thin covering of pure silver; the sulphur in the rubber, when set free by the action of vulcanizing, sulphurizes the surface, and to this the rubber adheres.

SILVER PLATE AND SOLDER.—The processes heretofore described and the rules laid down have been considered mainly in their relation to artificial teeth mounted upon GOLD PLATE by the operation of soldering. But other metals may be swaged by the same processes, as platinum, aluminium, and silver.

Silver is the least valuable of these, and has nothing to recommend it except its cheapness, in which questionable merit it has aluminium and vulcanite as its competitors, and hence it is now not very much used. It is manipulated in all respects like gold, except in the operations of refining by acids, the composition of solders used, and the care necessary in soldering from the fusibility of the plate.

For plates pure silver alloyed with platinum possesses advantages over coin silver, which oxidizes greatly in the mouth. The formula for such a plate is—

Pure silver, ...	1 ounce.
Platinum, ...	1 pennyweight.

Some prefer gold clasps for silver plates.

A good silver solder is composed of—

Pure silver, ...	6 parts.
Pure copper, ...	3 parts.
Pure zinc, ...	2 parts.

In the preparation of such a solder the silver and copper should be melted together and then the zinc added, pouring the molten mass into the ingot-mould before the zinc volatilizes.

Fine silver alloyed with one-third its weight of brass also gives a good silver solder, as the zinc in the brass reduces the fusing point of the alloy and makes it easy-flowing. If ½ to 1 grain of zinc is added to the above formula, the fusing point is still further reduced. After pouring the alloy into the form of an ingot, it should be rolled to No. 26 or 27, annealed, and its surface cleansed by placing it in the acid-bath.

Aluminium can be rolled into plate and swaged. It requires extreme care in annealing, but makes a rigid, strong, and very light plate. It does not withstand the buccal secretions as well as twenty-carat gold, nor is it as good as eighteen-carat gold. The obstacle to its general use also lies in the fact that as yet there is no good solder for it. Hence it is necessary to attach the teeth by vulcanite. This can be very successfully done, as vulcanized rubber adheres more closely to this metal than to any other, excepting, perhaps, pure gold or pure platinum. The process will be described in the section on Vulcanite; it is equally applicable to twenty-carat gold and to platinum, but not at all to silver. An alloy of aluminium which is cast directly upon the teeth is referred to under metallo-plastic work.

Platinum, if alloyed with five to ten per cent. of gold, has stiffness sufficient to be used as a base plate, in the manner previously given

for gold. As it has no advantage over gold when used in this way its less cost is not a sufficient offset to the inconveniences attending its use and to the color, which is so objectionable to most persons that they are unwilling to pay as much as for the same work in gold. Platinum has, however, one remarkable property possessed by no other metal used by dentists except palladium, which is now scarcely at all, if ever, used; it cannot be fused in the highest heat of the forge or porcelain-baking furnace. Hence it is the only metal used for the metallic pins and other fastenings inserted into porcelain teeth, requiring for its fusion the flame of the oxyhydrogen blowpipe. It is also the only metal used in a remarkably beautiful style of work known as the Continuous-Gum Work, which forms the subject of the next section.

CONTINUOUS-GUM WORK.

The idea of uniting porcelain teeth to a metallic base by means of a fusible silicious composition originated in France, where the method has to some extent been practiced since 1820. But Dr. Fitch, who spent much time in Paris and was well acquainted with the French method and Delabarre's formulæ, stated that the latter never perfected his recipes or brought them into practical use. The composition employed there, judging specimens, cannot be used in connection with porcelain teeth containing as large a proportion of feldspar as those manufactured in this country. Delabarre's compound, according to Dr. Locke, required 3761° Fahrenheit to fuse it completely. Below this it fused imperfectly and was found too fragile.

The process now known as the CONTINUOUS GUM consists essentially of a silicious paste, similar (except more fusible) in composition to that of which the teeth are made, which is applied around the bases and fastenings of teeth previously soldered upon a plate of purest platina, and then fused at a temperature of about 2200° Fahrenheit. It takes its name from the fact that, unlike blocks or single gum teeth, it presents an unbroken continuous gum outside the alveolar ridge, as is shown in Fig. 942. It is applied in two layers—a yellowish-white *body*, giving the general contour of the gum, and an *enamel*, to produce that correct imitation of the natural gum for which nothing but ceramic materials have as yet been found suitable. Dr. Allen covered with the same material the entire lingual surface of the plate, and also certain projections outside of the molars and

FIG. 942.

above the cuspids, designed by him for the restoration of the natural fullness of the face.

This falling in of the features is due to the absorption of the alveolar ridge, and cannot be fully restored by an artificial set of teeth as usually made; since if the molars were set out to the original width of the teeth the force of mastication would fall outside the absorbed alveolus and render it practically useless. Dr. Allen's device corrects this sinking under the malar prominence of the superior maxilla and in the canine fossa, and thus greatly aids in the restoration of the face to its original appearance.

This process was patented by Dr. John Allen in 1851; but the priority of invention was contested by Dr. William H. Hunter in a suit, the progress and result of which were published in the dental periodicals of that period. Dr. Allen surrendered his patents of 1851, owing to certain defects in the same, and in 1856 a new patent was issued to him for the process as then improved. The process is very generally known as "Allen's Continuous Gum." The formulæ given in this chapter are those of Dr. Hunter, and the earlier ones of Dr. Allen. As all such materials are more perfectly prepared on a large scale, we think it much better to purchase than to make them.

A "continuous-gum" piece made in the most perfect manner is only surpassed in point of beauty by the occasional productions of a very few block carvers; but so rare are these specimens of perfection in block work that we may safely say of the continuous-gum work that when properly made it is the most beautiful, as it certainly is the purest and sweetest, that can be worn in the mouth, so long as the porcelain covering maintains its integrity. It was thought when this method of mounting artificial teeth was first adopted that the springing of the plate in the act of mastication would cause the gum to crack and scale off, which did occur in a large proportion of the cases. Although the injury could be repaired by replacing the loss with fresh composition and fusing it to the fractured edges of the remaining portions and to the plate, yet this at one time formed a very serious objection to its use. But later improvements in the strength of the compound and also in the rigidity of the plate and soldered backings, or long pins, have so far corrected this evil that it is perhaps no more liable to accident while in the mouth than any other kind of work. But out of the mouth its weight renders it peculiarly exposed to accident; a fall is almost certain to break one or more teeth or crack the silicious covering of the plate. Hence it is necessary to impress upon the patient the great importance of the most careful handling.

By uniting the teeth to each other near their base and to the plate with a glazed porcelanic material, the cleanliness of the substitute is most perfectly secured; as all the openings beneath and around them are completely closed, excluding the secretions of the mouth and particles of food, which have no affinity for or action upon the porcelain. In this respect they are superior to the most perfectly mounted block-teeth, while the labor of putting up a set of the former can be performed in half the time required for making and mounting a set of the latter. A person who can mount single teeth well may acquire a knowledge of this method with proper instruction in a few weeks; although much of the peculiar talent required in block-carving is needed in arranging the teeth and shaping the gum for this process, the details are comparatively simple and may soon be taught. Of course, much practice will be required, especially in the management of the furnace heats. The necessity for such practice, to enable one successfully to manage the furnace, is the chief obstacle to its casual use by the practitioner. Unless he makes it a specialty, and does all his own work and some for his neighbors, he will be certain to meet with many discouraging failures in the final process of baking an otherwise perfectly constructed piece.

We therefore advise the dentist to swage the platina plate, select and arrange and articulate the teeth; for no one should be so competent to do this as the one whose intercourse with the patient enables him to judge exactly what form, color, and arrangement of teeth are best suited to the case; and only he can decide upon the correctness of the fit of the plate. But when all this is done the piece should be securely packed and sent by express or mail to some experienced worker in the continuous-gum. The piece will be returned with the plate unchanged in shape, and the porcelain work executed in such style as can be reached only by constant practice and familiarity with the special details of this work.

The artificial gum consists, as we have stated, of two parts; the first is termed the *base* or *body*, as this constitutes the principal part of the cement, and is used for filling in between the teeth and building up the gum on the plate; the other is *gum enamel*. The materials employed by Dr. Hunter in the composition of his compounds are silex, fused spar, calcined borax, caustic potash, and asbestos. The silex and spar should be of the clearest and best quality, and ground very fine. The asbestos should be freed from talc and other foreign substances and reduced to a fine powder. He gives the following formulæ and directions:—

FLUX.—Take of silex, 8 oz.; calcined borax, 4 oz.; caustic potash,

1 oz. The potash is first ground fine in a wedgewood mortar, and the other materials gradually added until they are thoroughly mixed. Line a Hessian crucible (as white as can be had) with pure kaolin, fill with the mass, and lute on a cover of a piece of fire-clay slab with the same. Expose to a clear, strong fire in a furnace with coke fuel for about half an hour, or until it is fused into a transparent glass, which should be clear and free from stain of any kind. This is broken and ground until it will pass a bolting sieve.

GRANULATED BODY.—Spar, 3 oz.; silex, 1½ oz.; kaolin, ½ oz.; completely fused. Break and grind so that it will pass through a wire sieve No. 50, and again shift off the fine particles, which pass through No. 10 bolting cloth, which leaves it in grains about the size of the finest gunpowder. It may be made of hard porcelain, fine china, or wedgewood ware.

BODY.—Take flux, 1 oz.; asbestos, 2 oz.; grinding together very finely, completely intermixing. Add granulated body, 1½ oz.; and mix with a spatula, to prevent grinding the granules of body any finer.

ENAMELS.—No. 1. Flux, 1 oz.; fused spar, 1 oz.; English rose red, 40 grains. Grind English rose red extremely fine in a mortar, and gradually add the flux and then the fused spar, grinding until the ingredients are thoroughly incorporated. Cut down a large Hessian crucible, so that it will slide into the muffle of a furnace, line with a mixture of equal parts silex and kaolin, put in the material, and raise the heat to the point of *vitrification*, not *fusion*, then withdraw from the muffle. The result will be a red cake of enamel which will easily leave the crucible, which, after removing any adhering kaolin, is to be broken down and ground tolerably fine. It may now be tested, and if of too strong a color tempered by the addition of *covering*. This is the gum which flows at the lowest heat, and is never used before soldering.

No. 2. Flux, 1 oz.; fused spar, 2 oz.; English rose red, 60 grains. Treat the same as No. 1. This is a gum intermediate and is used upon platina plates.

No. 3. Flux, 1 oz.; fused spar, 3 oz.; English rose red, 80 grains. Treat as the above. This gum is used in making pieces intended to be soldered on, either in full arches or in the sections known as *block work*. It is not necessary to grind very fine in preparing the above formulæ.

COVERING.—What is termed covering is made by the same formulæ as for the enamel, omitting the English rose red. Being without any coloring whatever, it is used for tempering the above

enamels when too highly colored, which may be done by adding, according to circumstances, from one to six parts of covering to two of enamel, thus procuring the desired shade. When it is to be used for covering the base prior to applying the enamel it may be covered with titanium, using from two to five grains to the ounce.

INVESTIENT.—Take two measures of white quartz sand, mix with one measure of plaster-of-Paris, using just enough water to make the mass plastic, and apply quickly. The slab on which the piece is set should be saturated with water to keep the material from setting too soon, and that it may unite with it.

MEMORANDA.—In preparing material always grind dry and use the most scrupulous cleanliness in all the manipulations. In all cases where heat is applied, it should be raised gradually from the bottom of the muffle, and never run into a heat. Where it is desired to lengthen any of the teeth, or to mend a broken tooth, it may be done with *covering*, properly covered with platina, cobalt, or titanium.

In repairing a piece of work wash it with great care, using a stiff brush and pulverized pumice stone. Bake over a slow fire to expel all moisture and wash again, when it will be ready for any new application of the enamel. Absorption occurring after a case has been sometime worn, by allowing the jaws to close nearer causes the lower jaw to come forward and drive the upper set out of the mouth. By putting the *covering* on the grinding surfaces of the back teeth in sufficient quantity to make up the desired length, this difficulty may be to some extent remedied.

Any alloy containing copper or silver should not be used for solder or plate, if it is intended to fuse a gum over the lingual side of the teeth, as it will surely stain the gum. Simple platinum backs alone do not possess the requisite stiffness, and should always be covered—on platinum with the enamel, and on gold with another gold back. In backing the teeth lap the backs or neatly join them up as far as the lower pin in the tooth, and higher if admissible, and in soldering be sure to have the joint so made *perfectly soldered.*

The compositions originally employed by Dr. Allen consist of—BODY: Silex, 2 oz.; flint glass, 1 oz.; borax, 1 oz.; wedgewood ware, 1½ oz.; asbestos, 2 drachms; feldspar, 2 drachms; kaolin, 1 drachm. ENAMEL: Feldspar, ½ oz.; white glass, 1 oz.; and oxide of gold, 1½ grains. Since the publication of the early editions of this work great improvements have been made in the composition and preparation of both the body and gum enamel, which are furnished by the manufacturers, and may be obtained at any of the dental depots at a very moderate price.

The metals which may be employed for the base in this method of mounting artificial teeth are platinum or pure palladium. The common commercial article of palladium is not pure, and is never used in this country. Platinum, alloyed with from 1 to 10 per cent. of pure gold, may also be used; but it is objectionable from its liability to spring or warp. It makes a stiffer plate and so far has the advantage over pure platinum, but for the reason given the purest metal should be selected. Because of its softness it must be used thicker than gold plate. The process of swaging the plate is the same as before given. It must be often annealed and gradually carried into any deep depressions, for its softness makes it more liable than gold to be torn, made thin, or punched through. A

FIG. 943.

FIG. 944.

narrow rim, partially turned up, is to be left around the outside. The process of articulating, etc., is similar to that for gold. In adjusting the teeth accurate grinding is unnecessary; but each tooth should *touch* the plate. Part of each backing, where the teeth are lined, should lap over the adjoining ones, and behind the six front teeth should also be lapped over an additional narrow band, to give greater rigidity to the plate. Continuous gum teeth with long pins are now used, the ends of the pins being bent down to the plate, to which they are soldered with pure gold; hence backing the teeth is not necessary. In this process there is great opportunity to give to

the teeth that irregularity of arrangement which forms one of the characteristics of natural teeth; neglect of which gives to many otherwise excellent pieces of work an unnatural, artificial appearance, that shows great deficiency in the cultivation of dental *æsthetics*.

Before applying the *body* the piece may be tried in the mouth and any inaccuracy of articulation readily corrected; careful articulation makes this trial unnecessary; but if from any causes changes are found on trial to be needed they can be made more readily in this work before the gum is added than in any other; since no joints or neat fitting to the plate are disturbed by changes in the position of a tooth. After this the piece should be set in a mixture of plaster and asbestos or plaster and sand, resting on a muffle slide and coming up around the outside of the teeth to keep them in place. The solder used must contain no trace of either silver or copper, as such metals will stain the gum enamel and body, but must be either pure gold or alloyed with about 5 per cent. platina. Borax may be used, not in this case as a flux—for where there is no oxidation no flux is required—but to hold the pieces of solder in place until ready to flow. The slide is then gradually carried in to the muffle, and the whole piece raised to the melting point of the solder.

Figs. 943 and 945 represent two of the most approved forms of furnaces.

Fig. 944 represents Verrier's furnace for continuous-gum work. It is operated with the regular house supply of gas, aided by the blast from the foot blower (Fig. 886). It is claimed that this furnace will fuse gum body or enamel in from five to ten minutes, but the small size of the muffle and its liability to "gas" the work are objections urged against its use.

Such accidents or effects are claimed to be overcome by the Combination Gas and Gasoline Furnace of Dr. Land, which is represented by Fig. 945, in which is shown this furnace thrown open, being swung on hinges at the back, exposing the muffle E. The groove P P is packed with asbestos fibre, so that when the sections are brought together the furnace will be perfectly air and gas tight. It is claimed that with gasoline gas porcelain teeth can be enameled in from ten to fifteen minutes, with ordinary illuminating gas in from fifteen to twenty minutes, according to quality.

The rules for the management of the heat are the same as hereafter given for block work. The heat required for this is not, however, so great as that required in block work; the gold and the continuous gum materials fusing at about 2200° Fahrenheit.

Having thus soldered and cooled off the pieces very gradually, it must be thoroughly washed, so as to remove every particle of invest-

ment. Then, with a camel's-hair brush and small knife, such as are used in block carving, the spaces between the teeth and plate are to be perfectly filled with a finely compacted paste of *body* and rain water. The paste must be applied very moist, so as to exclude the air and run into all the spaces; then dried with cloth or bibulous paper and compressed with the knife. If the lingual surface of the plate is

Fig. 945.

to be covered, this should be made rough by either etching the surface or by soldering small clippings of platina over it at the time the teeth are soldered. The natural rugæ of the palate should be imitated in the thin layer of body which is applied.

The work must then be slowly and thoroughly dried and the piece put on a slide with the coronal ends of the teeth downward, and imbedded to the depth of an eighth of an inch in a thick batter of plas-

ter and asbestos. But if the teeth are very securely soldered it will be best to flow the body with the plate resting, teeth upward, on the plaster and asbestos or sand model on which the soldering was done. The slide is then gradually introduced into the muffle and subjected to a heat sufficiently high to fuse the compound—say twenty-two hundred and fifty degrees. It is then withdrawn slowly and completely cooled. Usually there will be cracks and flaws which need filling with paste. The outside rim is also to be turned down over the edge of the body with hammer and pliers, and any defects at this point filled up; then heat a second time with the same caré as at first.

The piece, now ready for enameling, should present a semi-vitrified appearance; if too highly glazed it is too much done, and the enamel will not take so firm a hold; if too dull looking it is not sufficiently baked, and will be deficient in strength. The enamel must be applied moist, and is best put on with a brush; much plastering with a knife makes it apt to fly off in baking, and for the same reason it must be heated *very* gradually. The layer of enamel should be thin and irregular, the yellowish white of the body showing more or less through it, so as to give the variations of tint observed in the natural gum. If a thick and even layer is applied the result will be an unnatural uniform color, which will destroy much of the peculiar beauty of this work.

The greatest care is necessary in applying the paste to remove every particle from the parts of the teeth and plate which are not to be covered, as it adheres with great tenacity and roughness, and disfigures these parts. Much experience is also necessary in determining the exact heat necessary to develop the full beauty and strength of the work. Repeated heatings, either for the first making or for repairs, do not injure the plate or teeth, provided proper care is taken to heat and cool gradually; and provided, in case of repair, the piece is thoroughly cleansed in strong soda to remove all trace of the buccal secretions.

The work is peculiarly adapted to full lower dentures. The principles of construction are precisely the same, only the plate should be very heavy, and the extra band behind the six or eight front teeth very thick and strong. Many use it for partial cases; for which, however, it is not as well suited as for entire dentures. The three distinguishing advantages of the continuous-gum work are its ready adaptability to every variety in shape of gum and arrangement of teeth, its extreme beauty, and its great cleanliness; its three disadvantages are its weight, its liability to be broken by accident, and its comparative inapplicability to partial cases.

CHAPTER XIV.

MOULDED PLATES OF PLASTIC MATERIALS.

In the classification of operations for the Replacement of Teeth, given on pages 716 and 717, difference in the order of these operations was made the groundwork of a division of all BASE PLATES into two classes: SWAGED and PLASTIC. In describing, up to the point of completion of the model, the operations common to both classes, the modifying requirements of each were duly considered. The special order and details of swaged work were then taken up, with incidental allusions to plastic work, by way of comparison or contrast. Operations, materials, and apparatus peculiar to the latter will form the subjects of this and succeeding chapters.

PLASTIC WORK includes all dental substitutes in which the base plate is brought into contact with the teeth and the model of parts to be fitted whilst in a fluid, softened, or plastic condition, then hardened, during continuance of this contact, either by the application or the withdrawal of heat. Plasticity, as thus used, is the property of being moulded, and has already been spoken of as an essential quality of impression materials. In them it is associated with other qualities especially fitting them for this particular use; so in plastic work mere plasticity is of no avail, if other properties do not give to the material the qualities essential to a base plate. It must have strength and durability, and must be in harmony with the parts to which it is applied. This harmony implies that it shall not act injuriously upon the mouth or receive injury from it; that it shall not, in form, color, taste, or smell, be repulsive to patients. It ought not, if possible, to be even objectionable; but tastes are so variable that this contingency cannot be a positive ground for exclusion of an otherwise valuable material.

As in swaged work there are four metals of which plates may be formed—gold, platinum, aluminium, and silver—in plastic work there are five varieties of plastic material of which plates may be moulded: 1, Porcelain clay; 2, tin and its alloys; 3, sulphurated gum; 4, celluloid and modifications; 5, aluminium and its alloys; 6, electro-metallic. The first two have been longest in use; the third and fourth have become the most important in modern dentistry; the fifth and latest has yet to pass the ordeal of experience. The *first* is moulded by tools, not in flasks, as are the other four; it also requires intense heat to vitrify or harden it. The *second* is made plastic by fusion, requiring a flask, hot, to prevent cracking of teeth, and tight, to prevent escape of metal; these plates harden

by cold. The *third* and *fourth*, less plastic, demand force in the act of moulding; they are hardened by heat; but the temperature to which the teeth are subjected is less than in the other three. The *fifth* is made plastic by fusion; but, though more plastic than the third, in its pure state it does not flow as readily as the second; its extreme lightness and sluggish flow necessitate peculiar apparatus in moulding; but some of these disadvantages have been overcome by alloying it with other metals. The *sixth* is a process by which gold and silver are deposited upon the surface of the plaster model prepared for the purpose.

Comparing them in respect of certain other properties—weight, durability, strength, and necessary thickness of plate; amount of change in shape, from contraction; resistance to change by the action of the buccal fluids—vulcanite and celluloid are lightest; aluminium being thinner, is very nearly as light; porcelain, though a light substance, requires such bulk that it is heavier than either; tin and its alloys are heaviest. Vulcanite plates, properly made, are strong, durable, and may be as thin as any, except aluminium; aluminium plates are thinnest and strongest; the durability of pure aluminium plates is still an open question; tin alloys are variable, some being tough and strong, others stiff and brittle, others soft and flexible; they have about the same bulk as gum, and the best are perhaps nearly or quite as durable. Porcelain plates contract very much; aluminium much less, but still very considerably; tin alloys contract very slightly; gum has no contraction. Porcelain most perfectly resists the buccal secretions and substances taken into the mouth; vulcanite nearly or quite as effectually; tin alloys undergo some change; aluminium is not changed by sulphur, as silver is, but will probably be found, in some mouths, to undergo slight change.

To give uniformity to nomenclature, the four varieties of plastic work will be classed under four heads. 1. Ceramo-plastic, or porcelain. 2. Metallo-plastic, including tin, cheoplastic metal, other tin alloys, aluminium, and gold alloy. 3. Vulcano-plastic, including caoutchouc, gutta-percha, and all vegetable substances, that by combination with sulphur, iodine, etc., have the property of hardening by heat under the process known as "vulcanizing." 4. Celluloid and its modification, zylonite, which are moulded by heat.

CERAMO-PLASTIC WORK.

Porcelain plates are remarkable for cleanliness, and in the hands of a skillful worker in the ceramic art may have great artistic beauty.

There are, however, several considerations that must prevent their extensive use. Like continuous-gum work, ceramic plates are best adapted to full sets. They are frail, occasionally breaking under the force of powerful mastication; they will inevitably break, falling on any very hard surface. It is but just, however, to state that the few who make porcelain plates a specialty claim that they are no more liable to accident than other pieces; that the teeth of all, especially continuous-gum, are as apt to break as this work; and that a broken tooth or plate is more easily and quickly mended in porcelain-plate work than in any other.

A second objection is the great shrinkage of any strong porcelain substance. Efforts to correct in the material itself this shrinkage make it proportionately weak. Correction by enlargement of the model is not only troublesome, but it is uncertain; the same is true of the correction by grinding with corundum wheels, which is very tedious and cannot be exact. When base plates were made of ivory and fitted to the mouth by carving, this imperfection of porcelain plates was not objected to because the former fitted no better, if as well; but in contrast with the exact adaptation of other forms of plastic work and of swaged plates it becomes very manifest. There are many mouths in which a porcelain plate could not be retained at all; there are others which adapt themselves so readily to moderate inaccuracies that such a plate is worn with entire satisfaction.

A third objection is the necessity of constant practice to keep up that skill in ceramic art which is essential to an artistic piece, and to insure uniformity of result by proper control of the furnace. This difficulty, however, can be met in the same way as in continuous-gum work. If the dentist will make the model, select and articulate the teeth, arrange them on a temporary plate with wax to give the fullness of gum, and a sample tooth to show its color, then pack securely and send to any block carver or porcelain teeth manufacturer, he can have a porcelain plate made better and with more certainty than only an occasional practice will enable him to do for himself. If it is desired that the teeth and plate shall be carved at the same time it will be sufficient to send correct model and articulation, with directions as to the style, color, etc., of the teeth. We think, however, that it will be safer for the dentist to select and arrange the teeth, as he can better judge what is appropriate than one who does not see the patient.

For details of construction the reader is referred to other chapters. Impression and model are made like any other work; articulating processes are the same as for other forms of plastic work;

grinding the teeth is very simple, as in continuous-gum work; enlargement of the "furnace model" and manipulation of the porcelain mixture will be described in the chapter on Porcelain.

CHAPTER XV.

METALLO-PLASTIC WORK.

THE use of a fusible metal in the construction of base plates is by no means new; but many of the metallic compounds suggested or now used for this purpose are of quite recent introduction. Except aluminium none of them fuse above the melting point of tin, 442°. Pure tin is the oldest form of metallo-plastic base plate, and was used exclusively for the lower jaw. It is objectionable on account of its softness; even in a heavy lower rim it is apt to bend, and for an upper plate it is wholly unsuited. In its resistance to chemical change in the mouth it stands next to gold and platinum; is superior to silver and probably to aluminium; superior also, in this respect, to any of its own alloys. The process of constructing a lower plate of pure tin is the same as for any of the tin alloys.

Tin may be made harder and more rigid by alloying with Gold, Silver, Copper, Antimony, Zinc, Lead, Bismuth, or Cadmium. Copper and lead make it unfit for the mouth; antimony, zinc, and bismuth make it brittle, unless used in very moderate proportion. Silver gives it hardness, also cadmium, without imparting the objectionable properties named. Probably the best of all alloys for tin is cadmium. Closely resembling tin in its physical properties, it hardens it without making it too brittle or imparting increased liability to the action of fluids of the mouth. The majority of tin alloys at present recommended for base plates contain cadmium, with some zinc, antimony, or bismuth; they ought not to contain copper or lead. In absence of their formulas of composition it is impossible to say that they will prove injurious or harmless in the mouth, or that they will undergo no change by time. Even if we knew the formulas it would, in some cases, be impossible to speak positively on this point.

The primary strength of any of these alloys can be easily detected; with rather more trouble its fusion point and free flowing qualities may be learned. For all else the safest rule is to use any or all of them "under protest," until by personal observation every one as-

certains for himself how far they are free from change or keep their original strength after being worn. It may be thought that such distrust of the assertions of others is unprofessional. Possibly it may be; but what other course is open to any careful operator in the face of such circulars as the one just received by the writer, in which a certain "rubber preparation" is recommended, as enabling the dentist to complete a set of teeth in "one hour after taking the impression." The sad truth is too notorious for concealment, that the inventors of dental "improvements" are like the discoverers of quack medicines—they magnify excellences, conceal defects, substitute assertion for evidence, and claim a confidence in their inventions which should only be the slow growth of experience.

Experiments in tin alloys, unlike those in vulcanite compounds, are easily made by any well informed dentist; he can have his favorite tin alloy, as he has his pet solder, both the result of his own experimenting. He can judge at once of certain properties; for others he must wait the teachings of experience. If he prefers to use the labor of another and buy an alloy which pleases him, but of which he really knows nothing, why should not full judgment upon this also be suspended until a jury of his patients have rendered their verdict.

Cheoplastic, Wood's, Weston's, and Watt's Metals.—The Cheoplastic Metal was patented by Dr. A. A. Blandy in 1856, together with certain processes used in the construction of dental plates. The manipulations since so familiar in the working of vulcanite were then as unknown as vulcanite itself. The peculiar merits of plastic work were at once recognized by many of the profession, and the Cheoplastic process would have passed into very general use, with such modifications as experience may have dictated, had it not been for the introduction of Hard Rubber. After some years' contest the profession decided in favor of rubber. Dr. Blandy's departure from the States in 1862 and the failure of the supply of his metal led to a total disuse of the cheoplastic metal.

The abuses of vulcanite and the gross mismanagement of rubber patents during their continuance urged many advocates of plastic work to revert to various tin alloys which are, in their principle of composition and in the essential character of the processes employed, identical with Dr. Blandy's patents. The name chosen by him (signifying the making of plates by *pouring* a metal made *plastic* by heat) is equally applicable to all alloys of tin now used. The alloy of the cheoplastic metal was silver with some bismuth and a trace of antimony. The exact proportions are not known, but may be learned by reference to the patents. The alloy imparted no taste

whatever to the mouth; and its purity, so far as its capability of resisting the action of the secretions of the buccal cavity is concerned, was said to be equal to eighteen-carat gold. Its color became slightly darker after being worn some weeks, but could be restored by placing it in a strong solution of caustic potash.

The cheoplastic metal was the pioneer of the numerous alloys of tin (stannum) which are now claiming the attention of the profession. We have elsewhere spoken of the necessity of testing all such alloys in the crucible of "practice." We shall mention those of Drs. B. Wood, H. Weston, and George Watt. The first because next to the cheoplastic metal it has been longest known to the profession, particularly those alloys adapted to the filling of teeth. The last because they are very strong, flow well, and retain their color well.

Of the composition of Dr. Weston's alloy we know nothing beyond an assurance that it contains no copper, antimony, zinc, or

Fig. 946.

lead. It may be better than any of its competitors closely resembling it; but, in ignorance of the formulæ of any of them, we can only say what, perhaps, if we knew these formulæ we might still say—submit to the test of experience that which seems to be the best. Dr. Wood's alloys are the result of an elaborate series of very careful experiments made some ten years ago. His plate alloys consist mainly, perhaps altogether, of tin and cadmium; they vary in fusibility, hardness, and rigidity, but are nearly, if not all, more

fusible than Weston's metal. Dr. Watt's metal is said to withstand the chemical action within the mouth as well, if not better, than 18-carat gold, and to be strong and to run sharp. Moulds may be made in almost any flask, but a special flask known as Watt's moulding flask (Fig. 946) is better adapted to the use of this metal than the ordinary flask. The following instructions, in connection with what remain to be given for vulcanite, will be a sufficient guide in the construction of plates made of Wood's, Weston's, Watt's, or any other stannie alloy.

Teeth for rubber work are best suited for this with the following precautions: First: Grind off the thin upper edge of gum teeth or sections; the anterior band is useful in rubber and does no harm; if of metal it is apt to crack the block and is unnecessary, as teeth are rather more firmly set in metal than in rubber; hence no metal should overlap the upper edge of the gum. Secondly: In jointing blocks do it as squarely as possible; if merely the edges of gums touch, the slight contraction of the alloy may cause them to scale or break. If, however, from accident or necessity this last kind of joint occurs, do as in soldering blocks to gold plate—place a thin piece of paper in the joint before securing it to the wax plate. Before drying the flasks this slight space caused by the paper may be closed with plaster and soluble glass, to prevent metal from running in and making a metallic seam on the front of the block. Thirdly: Be careful to cover the pins with the wax which gives shape to the metal, so that in finishing up the latter they will not be exposed.

Fig. 947 represents Weston's improved flask, which consists of two rims without top or bottom, to permit rapid escape of moisture. It is much larger than the ordinary flasks, so as to allow room for the gate and reservoir posterior to the plate. It closes with two small bolts with nuts, and stands on feet. It is very important to screw the flask up well before pouring, that the weight of fluid metal may not separate the halves of the flask; the slightest space will allow much or all the metal to flow out.

The plaster may be mixed with soapstone powder, pumice powder, or clean white sand. Asbestos would prevent shrinkage, but its fibres would interfere with the free flowing of the batter. The same care in heating the flask is necessary as before stated, remembering that plaster confined in metal flasks takes longer to become dry. It is not safe to pour under less than three hours' drying; and this must never be done in direct contact with flame. Moisture is one of the products of combustion in all flame, and is largely absorbed by the plaster; hence plaster over flame can never

be made perfectly dry, unless contained in some box, say of sheet iron, excluding this vapor.

Directions for heating, pouring, cooling off, and finishing are as follows:—

All necessary trimming of the plaster is done before the wax is removed, to prevent small pieces from falling in the matrix by the sides of the teeth. All of the wax is now removed, as the absorp-

Fig. 947.

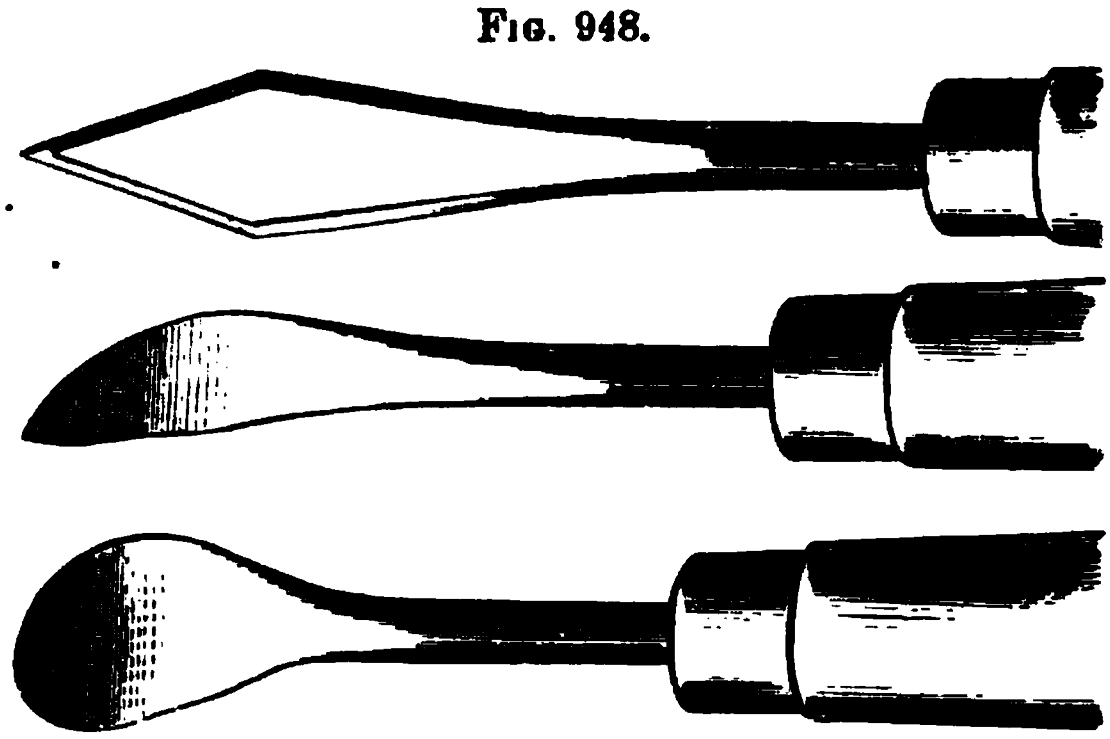
tion of any considerable portions left in the matrix has a tendency to roughen the surface, and thus to prevent the metal from running as smoothly as it would otherwise do. After removing the wax each half of the matrix may be held over the flame of a tallow candle until a slight coating of lampblack forms on it. The two parts are now screwed firmly together.

The flask may now be placed in a kitchen range or bake oven

and exposed to a bread-baking heat, say from 300° to 400° Fahr., for from three to five hours, or until every particle of moisture is driven from it; then placed in an upright position and the melted metal poured quickly into the matrix. If there is no ebullition and the metal comes up into the vents freely, the piece will come from the matrix in a perfect condition. If it bubbles it may be lightly tapped several times on some hard surface. When perfectly cold the two parts of the matrix are separated, exposing one of the surfaces of the plate.

When the process is properly conducted from the beginning up to the point of pouring the metal, the piece will come from the matrix perfect in all its parts. But when the metal fails to flow freely around the teeth, and to cover perfectly the alveolar border and palatine arch, it is better to replace the removed half of the matrix; then, turning the gate down, heat it up to the melting-

Fig. 948.

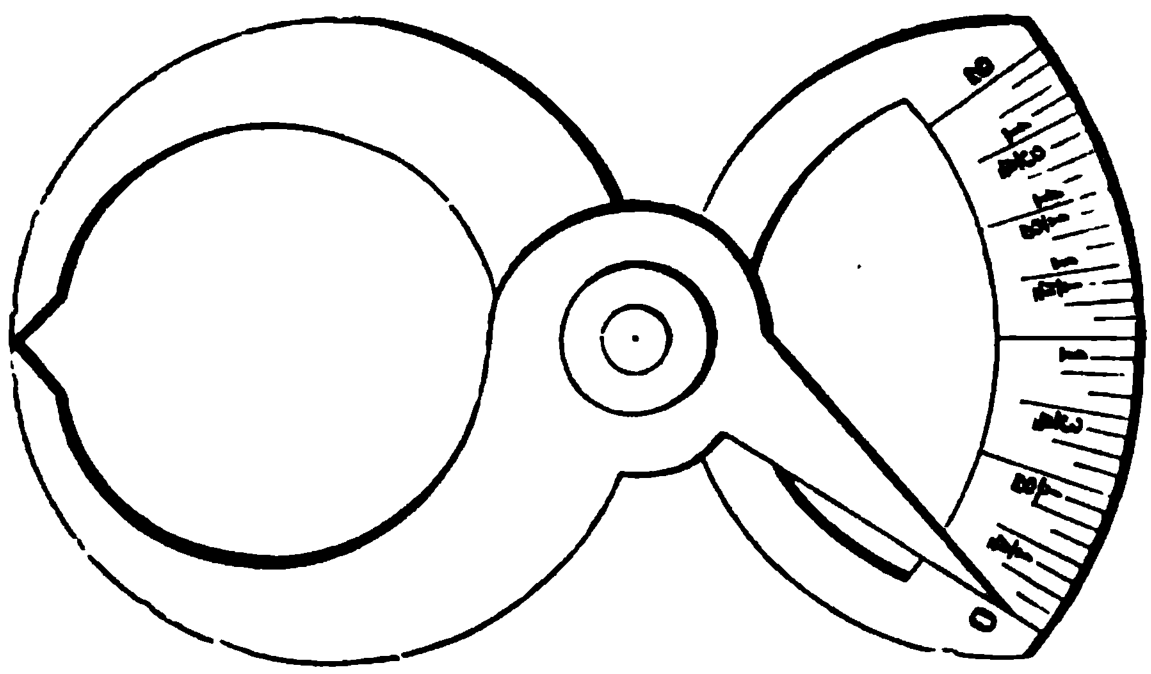


point of the metal, place again in the sand-bath, and pour a second time. Attempts are sometimes made to patch the plate where the defects are small; but it will prove far more satisfactory in the end to pour it entirely anew. The matrix should become entirely cold before any attempt is made to remove the piece; otherwise there will be danger from the sudden exposure of warm teeth to the air. The plaster mixture is easily cut; dipping it in water will make it softer and more easily removed.

If care has been used in shaping the wax plate, if the plaster has been kept free from air-bubbles, and if the joints between gum teeth or blocks have been nicely jointed and filled on their front edge, with the plaster moistened with soluble glass, the piece may be finished with little trouble. The gates and vents and irregular edges of the plate may be sawed off or removed with coarse files; fine-cut files become clogged with the metal. Scrapers (Fig. 948) may be

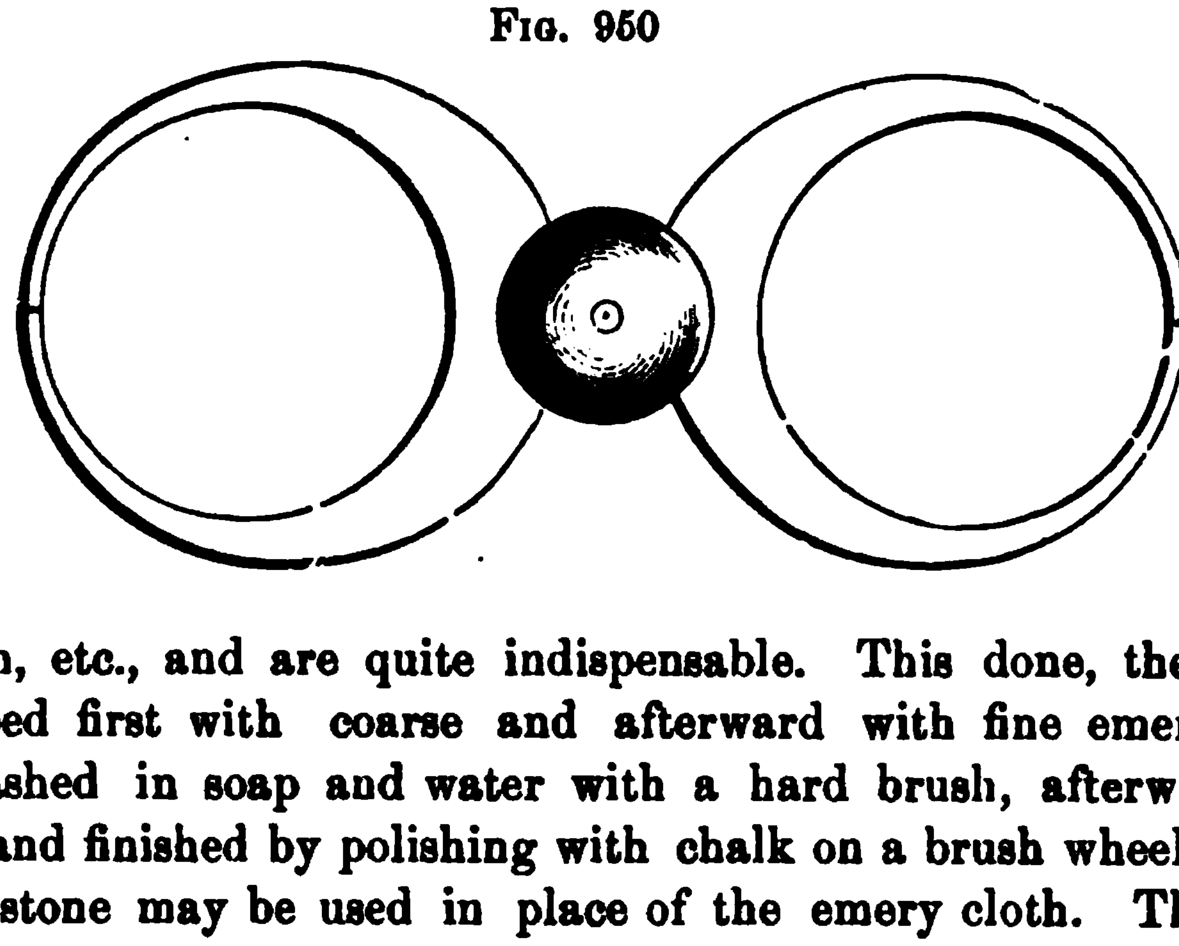
employed for removing the roughness of surface—curved and rounded for the inner surface, flat, straight-edged, and pointed for outer surfaces or dental interstices. If carelessness in making the wax plate renders it necessary to cut away much thickness of metal the lathe burrs used for vulcanite will be found useful. In reducing the thickness of plates frequent use of calipers (Figs. 949, 950)

FIG. 949.



is necessary to avoid the accident of cutting through the plate. This is especially apt to happen in the use of lathe burrs. Fig. 950 should have the tips on one side pointed, as in Fig. 949, and they should be occasionally examined to see if both sides come together alike. It will make the use of calipers more easy if the arms are kept permanently open by an elastic band, closing by pressure of the fingers at each trial of the plate. Graduated calipers are useful also for measuring the depths of articulating rims, the length

FIG. 950



of teeth, etc., and are quite indispensable. This done, the surface is rubbed first with coarse and afterward with fine emery cloth, then washed in soap and water with a hard brush, afterward burnished and finished by polishing with chalk on a brush wheel; coarse Scotch stone may be used in place of the emery cloth. The upper

surface of its plate must neither be scraped nor polished, as the accuracy of the adaptation to the gums and palatine arch would be injured; it should simply be washed well with a brush, using, perhaps, a little whiting. Every other part ought to be finished in the neatest and most perfect manner; the piece is put in a strong solution of caustic potash, boiled for two or three minutes, then washed in pure water, wiped dry, and finished with chalk and the brush wheel.

Under no circumstances should the tin alloy be gilded. The least imperfection of the electrotype deposit, or the abrasion of any edge or prominence, or the removal of the coating by trimming the plate at any point, presents to the fluids of the mouth two metals having widely different galvanic relations; electric action is inevitable, causing decomposition of the plate, annoyance to the patient, and often ulceration of the gum. The tin alloys are quite harmless in the mouth. They all slightly tarnish, but the surface oxide seems to protect from further action, except where abraded by the mastication of food. The brilliant polish of new work cannot be kept so long as on a gold plate, because it is much softer; this, however, is of secondary importance, provided the metal is hard enough to resist wearing away under the necessary operations of use and of cleansing.

In mounting a set of teeth for the lower jaw the gate through which the metal is poured into the matrix should have two lateral branches, one on each side, to admit the metal more freely. The wax plate should also be thicker, to give sufficient strength and stability to the base; in other respects the process is the same as that described for an upper set. For a partial lower set of molars and bicuspids on each side the wax plate should be extended behind the remaining front teeth; and two or three thicknesses should be applied here, giving stiffness sufficient to prevent breaking or bending under the pressure of mastication.

In making an antagonizing model for an entire set of teeth the wax plate for the lower jaw is stiffened by the adjustment of a stout iron wire, bent to the curvature of the arch, and made fast to and partly bedded in the plate. The rim of wax is now arranged on the ridge, and after being properly trimmed it is taken from the model. Upper and lower plates are then adjusted in the mouth, the articulation is obtained, and the articulator (Fig. 951) made in the manner described for a full set of teeth mounted on gold plate. Fig. 952 represents a double set of teeth arranged in wax upon a plaster articulation, ready to be placed upon their respective models preparatory to the formation of the remaining halves of the ma-

trices. The cast base process is also applicable to partial sets of teeth; a single tooth or several teeth situated in different parts of the arch can be replaced, and retained so as to occasion no inconvenience or annoyance to the patient. The only precaution necessary to be observed in their construction, in addition to that of accuracy of adjustment and neatness of execution, is to thicken the projections of the wax plate between the remaining natural teeth sufficiently to give strength to the metal at these points. These portions, when very narrow, should have twice the thickness of the other parts of the plate. Clasps cannot be used, as the metal itself has no elasticity, and gold clasps could not be connected to such plates. With this exception the forms of partial pieces for this work are the same as for vulcanite work, hereafter described. After having adjusted the artificial teeth and made them fast to the wax plate the teeth of the model should be cut off before

FIG. 951.

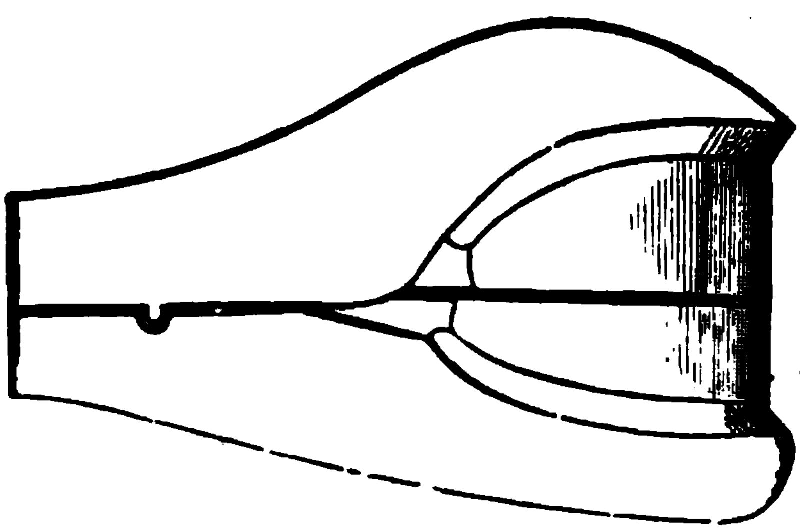
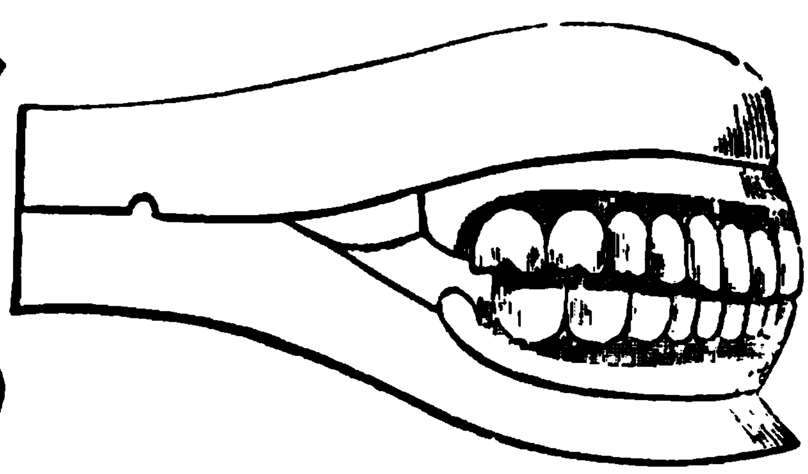


FIG. 952.



making the other half of the matrix, as it would be almost impossible to separate the two halves without breaking the teeth and other important parts.

But if proper flasks are used it is not necessary to cut off the teeth. In the same manner as hereafter described for that work, the model may be set in the deep half of the flask until the edges of the teeth are nearly or quite level with the edge of the flask; the investing plaster supports the outside of the teeth and prevents breakage on separating the flask.

A piece from which one or more teeth have been broken can be easily repaired. If any portion of the tooth remain it is removed, and the metal that united it to the base filed away; a new tooth is selected and ground until it corresponds with the adjoining teeth; it is then put in place and wax applied on the outside and inside of the tooth, smoothing it with the warm wax-knife evenly with the plate. The apex of a conical-shaped roll of wax about an inch and a half in length is united to the wax on the back part of the

tooth; the apex should be little more than an eighth, and the base half an inch in diameter, which latter should be half an inch above the edge of the teeth. A small stem of wax is united to the wax on the outside of the tooth with the free extremity half an inch above its edge. The one-half of the flask is now filled full of the plaster mixture, and the piece put immediately in it with the base downward, first filling the irregularities of the plate with the plaster; the top or other half of the flask is then put on and a thin mixture of the same composition is poured on top, filling the ring and covering the edges of the teeth about a quarter of an inch. When hard the projecting stems of wax are withdrawn; the wax on each side of the tooth and between it and the base will be melted and absorbed during the drying process. The matrix is dried in a stove or furnace, being careful not to heat it up to the point of fusion of the plate. The alloy is then melted and poured into it through the gate behind the tooth, and if it flows, filling the vent in front without bubbling, the piece will come from the matrix perfectly restored. When cold the plaster mixture is broken from the teeth and the metal around the new tooth finished according to the direction given for full sets. In repairing pieces the heating of the matrix and metal must be done very carefully. If the matrix is too hot, the plate may fuse; if too cool and the melted metal too hot, the porcelain may be cracked. In using tin alloys in connection with platina pins it should be remembered that the exposure of a single rivet to the action of the buccal fluids forms a galvanic battery, which will cause an unpleasant taste and render the piece liable to slow decomposition; hence all pins must be carefully covered with metal, so as not to be exposed in the finishing processes.

We have seen pieces made of Weston's alloy which, after cutting off the gate and vents, were ready for the emery-cloth and brush-wheels. This result can be uniformly secured by care in shaping the wax and proper attention to temperature in pouring. These alloys have a slight shrinkage, not sufficient to break blocks or chip the edges if the directions above given are observed. The slight shrinkage may give these plates an advantage over vulcanite in point of adaptation. Directions for repairs are the same as in other alloys. It is also recommended to mend a broken tooth by investing as for gold soldering; then dry the piece, use muriate of zinc for a flux, and solder with blowpipe or soldering iron. After melting one-half the pieces and disfiguring the half of the remainder, it will probably be concluded that the seemingly more tedious process is the shortest. Still, we do not object to trial of the blowpipe

and soldering iron; experience is the best of all teachers, perhaps, because she enforces her teachings by such hard blows.

The strength of the Wood or Weston metal permits its use for partial pieces and allows stays to be formed on the plate; but full clasps cannot be made because alloys of this class are not sufficiently elastic. The form of such plates will be discussed in the next chapter. In preparing the above directions we have discarded some innovations upon other processes as being anything but improvements; such, for instance, as the recommendation to heat to 210°, or, "so that it can hardly be held in the hand," a flask containing teeth on to which a metal is to be suddenly poured at a temperature of 440°. This temperature may be quite sufficient, however, for some of Dr. Wood's alloys. The safest rule in all cases, except for repairs, is to heat up to the fusion point of the alloy. As an offset to this error we notice a good suggestion for removing small remnants of wax by washing out with hot water. It has an advantage over the plan of allowing the hot, dry plaster to absorb the wax, in permitting examination of the pins and joints and allowing closure of front joints with plaster; also by enabling the mould to be thoroughly cleansed just before closing it prevents the accidental retention of small particles of plaster which may interfere with the flow of the metal.

Aluminium Work.—This metal is in nearly all works on chemistry called Aluminium, making it similar in termination to twenty-three other metallic bases discovered by modern science and known by Latinized names ending in *ium*. None of these, however, have any practical value in the arts as metals, except cadmium, magnesium, palladium, rhodium, and iridium.

Sir Humphry Davy inferred from his discovery of sodium and potassium that alumina was the oxide of a metallic base. This conjectural metal, named Aluminium, was subsequently discovered by Wöhler, but remained for more than twenty years a mere chemical curiosity, until in 1854 St. Clair Deville succeeded in manufacturing it in large ingots by the action of sodium upon the chloride of aluminium; but the cost of metallic sodium made this an expensive process. He subsequently obtained it by the action of chloride of potassium upon the once rare mineral, Cryolite—an alumino-fluoride of sodium, large deposits of which have been discovered in Greenland.

All rocks, except limestones and some sandstones, contain alumina; and it enters largely into the composition of all clay and slate rocks; hence next to oxygen, which constitutes one-half of the globe, and silicon, which forms one-fourth, alumina is the most

universally diffused of all metallic oxides, and aluminium is the most abundant of all metals. The vast beds of iron ore become insignificant compared with the ore beds of aluminium. As iron is now the most useful as well as the most abundant of all metals, it may not be unreasonable to anticipate the time when the extent and variety of uses to which aluminium will one day be applied shall be proportioned to the vastness of its ore beds. The present use of aluminium in dentistry and in the arts generally bears a small proportion to its future use, when its properties shall become developed, the manner of working it better understood, its metallurgy simplified, and its relations to other metals ascertained by experiment. Its valuable qualities now known and its history during the sixteen years just passed go far to justify these expectations. We shall give a brief summary of the present state of knowledge of aluminium.

It is the lightest metal known except magnesium (excepting also, of course, sodium and potassium); its specific gravity is 2.56 for cast metal and 2.67 for hammered metal, about the weight of glass or porcelain. Its point of fusion is somewhere near 1000° Fahrenheit. It is malleable, laminable, and ductile in a high degree; has a hardness equal to silver and excels it in point of tenacity; it is eight times better than iron as a conductor of electricity, being nearly equal to silver. Unlike silver, it wholly resists the action of sulphur, also of nitric acid, unless it is boiling. Sulphuric acid does not affect it, nor do the vegetable acids, as citric, oxalic, and tartaric. Its proper solvents are hydrochloric acid and chlorine. It is somewhat affected by the caustic alkalies, soda, and potash; also, perhaps, by ammonia and quicklime. A solution of salt and vinegar is said to affect it, possibly due to a liberation of the chlorine in the salt.

Its record of resistance to change by acid and alkali is a very fair one, and gives rise to the conjecture of possible impurity of metal in explanation of the cases reported in which aluminium plates undergo change in the mouth. The conjecture is strengthened by the peculiarity of this change; it occurs in spots, seeming to indicate some local impurity or alloy, not by a general discoloration of the plate, such as we see on eighteen-carat gold, or silver, and on the stannic alloys. The subject of aluminium alloys in connection with the mouth and as solders is an open field of inquiry, and researches may some day be crowned with the discovery of an aluminium base plate equal in all respects to gold plate, with the peculiar advantage of its remarkable lightness. Present experience

is unfavorable to its power, in its pure state, of resisting the buccal secretions.

Aluminium plates may be swaged, teeth backed and soldered by the blowpipe, just as in gold work. The best solder for this purpose is probably Dr. Starr's, containing seven parts aluminium to one of pure tin. Soldering is also done with a copper soldering tool similar to that used by tinners, sometimes by the combined action of both. But the results as yet reached in the experiment of soldering aluminium do not justify us in recommending this form of plate; hence we shall not give any description of the processes referred to, although esteeming them highly as experiments. The swaging of aluminium is done just as in the case of gold or platinum, except that frequent annealing is necessary. The annealing must be done with extreme care, since the fusion point of the metal is so little above red heat that the slightest excess of heat will warp, blister, or melt the plate. For the purpose of annealing it is suggested to coat the surface of plate with oil, and then pass it over the flame of a spirit-lamp until the oil is burned off and the plate becomes white, when it is instantly withdrawn. The extreme lightness of this metal permits the use of a plate two or three times the thickness of gold plate; hence aluminium plates may be the very strongest that can be made in any given case. The best method yet proposed for attaching the teeth to such a plate is by vulcanite, the details of which process will be given in the next chapter. It is a peculiarity of pure aluminium that vulcanized rubber adheres to it with great tenacity. A set of well-chosen block teeth, skillfully arranged and secured to an accurately fitting aluminium plate, may safely be offered to the most fastidious and critical patient. It has, moreover, the great advantage that "sixty-minute" dentists will not care to imitate work which takes "several" hours to do even passably well.

Another form of aluminium work, and that which has led to the present classification of this metal under the head of Plastic work, was the moulded or cast aluminium plate. No experiments, however, seem to us to have been conducted with such care as those of the late Dr. James B. Bean, of Baltimore, who perished under an avalanche, in the summer of 1870, while ascending Mont Blanc; and his process was not only a difficult one to pursue, but was very uncertain in its result; hence the use of aluminium is not at the present time attempted except in the form of swaged plates to which the teeth are connected by vulcanized rubber, and which is referred to in the article on Vulcanite.

The use of aluminium in dentistry is of comparatively recent origin, the properties of the metal undeveloped, and its most appro-

priate manipulations as yet undetermined. Although experiments thus far indicate a want of durability, they reveal properties which should stimulate to renewed effort in overcoming acknowledged difficulties. Taking lesson from the injury which the cheapness and facility of vulcanite have inflicted upon prosthetic dentistry, we may possibly find in aluminium a dental base possessed of an unsurpassed combination of excellences, requiring, however, for their development an amount of time, care, and skill that will exclude it from the practice of those who are doing such discredit to their vocation. We should regard this exclusion as one of its highest recommendations to the notice of all who seek, by the excellence of their work, to do honor to their profession.

Aluminium Cast Base.—Dr. C. C. Carroll uses a prepared form of aluminium which he describes as being first made pure to prevent disintegration, and then alloyed with a small per cent. of noble metals that expand in cooling and thus compensate the contraction of the aluminium. He describes his method as follows:* "The contraction of the metal is reduced to the one-tenth part of a line, or the one-hundred-and-twentieth part of an inch, practically nil, enabling us to cast directly upon the teeth without a fracture. The difficulty of making a sharp cast of aluminium by virtue of its low specific gravity is overcome by the use of our pneumatic crucible, which enables us to force the molten aluminium into every part of the matrix, producing a perfect cast of the model.

"We take an impression for this aluminium cast work as we would for any other work; then from this impression make a model of plaster-of-Paris, three parts, and of fine sand or marble dust, one part. Now we proceed very much as in rubber work. For temporary base plates we take common paraffine wax and roll it down to about twenty-three standard gold plate gauge.

"Fig. 1 shows the temporary base plate on the model, and invested in the flask with a section of flask and investing material cut away. *a b* is the middle gate; *c c*, gates from the heel to the middle gate; *d d*, perpendicular gate; *e f*, the flange on base plate; *h*, base plate cut through to show position on the model; *v v*, direction of metal in casting.

"Fig. 2 shows a denture mounted and invested in counter model of flask for Base No. 2, one-half, with the wax removed, or for Base No. 1, when to be cast directly on the teeth.

"Fig. 3. *f f* represents the line of the flange after attachment with rubber or celluloid; *a a*, alveolar edge of plate.

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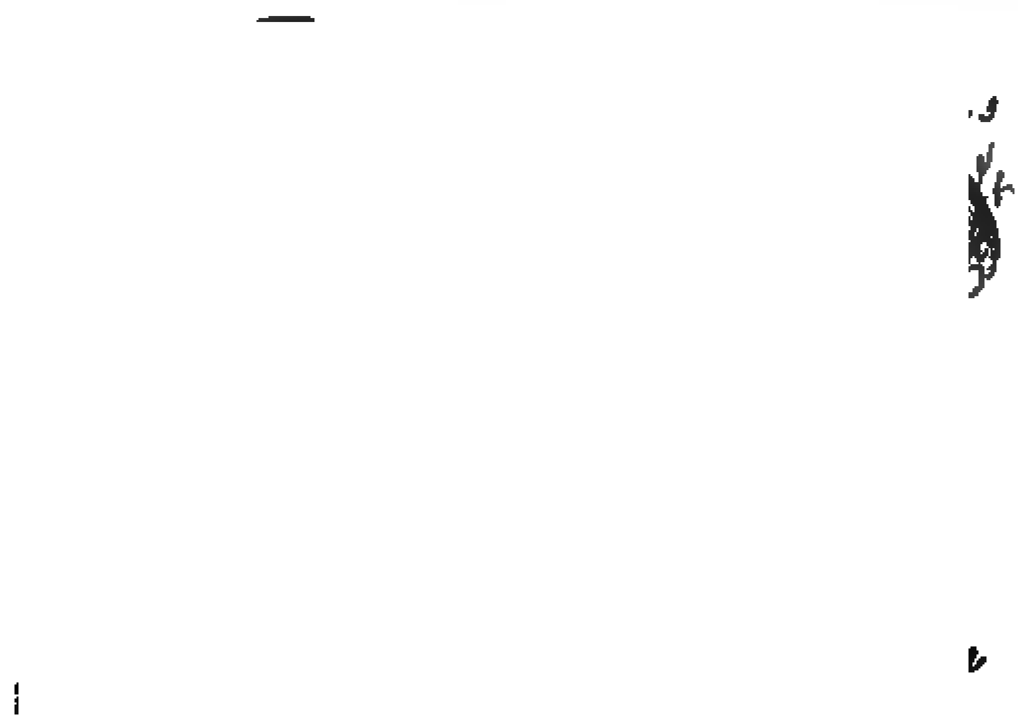
* *Dental Register*, June, 1888.

"There are various forms of mounting the common rubber teeth which we used in this aluminium cast work, the simplest of which is to cast a base plate with a flange or undercut for the purpose of attaching the teeth by pink rubber or celluloid. Upon this cast base plate we place wax and get the bite, which we place upon the articulator and mount in the usual manner for rubber work. Then attach the teeth to this aluminium base plate, making an artificial gum of pink rubber or celluloid.

"Another form of mounting is to place plain teeth directly upon the temporary wax base plate, the same as in mounting for rubber

FIG. 953.



work, with the exception that you space your teeth slightly to allow for this slight contraction. Along the alveolar border we make an undercut in the wax base plate, which undercut is reproduced in the aluminium plate permanently when cast, for the attachment of a gum-colored facing of pink rubber or celluloid. We now invest the tooth upon the model in the two-part perforated iron flask very much after the manner of investing for rubber work, Fig. 953. Cut gates from the centre part of the base plate to the pouring point of the flask, also pockets from the heel of the base plate into which the

air is forced through the matrix in the act of casting. The wax base plate is removed by washing out with hot water, and the flask placed in the upper chamber of the automatic gas (or gasoline) furnace to be dried out preparatory to casting. You will observe that by this method of mounting we intend to cast the aluminium directly upon the teeth, attaching them firmly to the plate.

"Gum section teeth can be used as well as plain teeth by exercising care in the method of mounting, taking the precaution of placing a thin slip of paper between the joints before investing.

"When the matrix is dry, which will be shown if no moisture appears upon a mouth mirror held over the pouring point, we make the cast by use of an automatic crucible, which is placed in the

FIG. 954.

lower chamber of the furnace and contains the aluminium to be used in casting. The crucible is placed upon the flask, connecting the nipple of the pneumatic crucible with the pouring point of the flask, and by means of a rubber bulb the aluminium is forced into the matrix, making a very sharp and well-defined cast which is a perfect counterpart of the model (see Fig. 954). As soon as the piece has cooled, the flask is opened and the denture removed. The piece is then finished up by means of sand-paper and pumice

stone, using fine crocus for a finer polish. It takes and retains the appearance of the finest polished nickel plate.

"All forms of dentures are readily made by means of this aluminium cast work, including crowns, bridges, as well as partial and complete dentures.

"While aluminium, by virtue of its extreme lightness, having a specific gravity of 2.5, is peculiarly fitted for upper dentures, it is better to have a heavier metal for lower dentures."

Gold Alloy Cast Base.—Dr. G. F. Reese has recently devised an alloy composed of gold, one part; silver, two parts; and tin, twenty parts, which is manipulated by a special method, as a base for artificial dentures, and which has met with considerable favor. A brief description of Dr. Reese's method is as follows: A plaster model is first obtained from a plaster im-

Fig. 955.

pression of the mouth, and on the model a trial plate is made of gutta-percha, paraffine, and wax, or of modeling composition. Upon this trial plate the teeth are arranged and tried in the mouth. If satisfactory the waxing about the teeth is completed, and the portion of the trial plate covering the palatine surface is removed to such a degree as to nearly expose the pins of the teeth, the wax under the gums being allowed to remain. For the portion of the trial plate removed two thicknesses of French flower wax is substituted, being carefully adapted to the model.

Fig. 955 represents a case carried to the stage described, the dotted lines showing the edges of the thin wax substitute portion, and B,

A, and C prominences of wax attached to the posterior border and portion of the plate covering the maxillary tuberosities, A and C being designed for the escape of the alloy which is poured in at B. The case is then placed in a brass flask, which has been oiled to render its removal from the investment easy. Fig. 956 represents the case in the flask ready for investment. To invest the case each section is placed upon a plate of glass and plaster poured in until it is half filled, when the model, which has been saturated with water, is pressed into the plaster batter until the teeth and gums alone remain uncovered. The counterpart of the flask is then set on and sufficient plaster poured in until the prominences of wax

Fig 956.

along the posterior border of the trial plate are slightly covered. After the plaster has set the upper section of the flask is removed and the surface of the plaster coated with shellac varnish. The section of the flask is then returned to its place and the investment completed by filling it up to the edges with additional plaster. When this has set the flask is placed in hot water in order to separate the sections easily. The wax is then removed and also the sections of the flask by gently tapping them, and communication made from the outer surface with the cavities left by the wax prominences along the posterior border of the plate; or, if this is impossible, the vents and gates may be formed at the line of division

between the sections, as represented by the dotted lines in Figs. 957 and 958. Externally the openings D, E, and F, Fig. 958, should be enlarged by reaming out the plaster and varnished with shellac, to receive the cylinders, which latter are made of wax, rolled thin, and wrapped around a cone-shaped piece of wood. These cylinders are about one and a half inches long and about half an inch in diameter at the base, tapering to an eighth of an inch at the apex.

Fig. 957.

The pouring-cylinder is usually made somewhat smaller at its base than the others, but some two inches long. Wax covers are attached by a warm spatula to the larger ends of the cylinders, so as to make them water-tight. Fig. 957, *d*, *e*, *f*, shows the cylinders

thus prepared and attached. In case the openings have been made through the plaster investment of the lower section, as represented in Fig. 957, then the upper section, Fig. 958, need not be united to it until the openings have been formed upon the line of division, when the sections must be joined before the cylinders can be attached. The case is then placed in a larger flask, Fig. 959, and invested as before, allowing the end of the pouring cylinder to rest in the opening of the posterior border of the flask. In this investment there is no division of the sections after the parts of the flask are filled. The case is then dried in an oven, all of the wax being absorbed by the heated plaster, until all moisture is expelled. Several grades of the alloy are used by Dr. Reese, which melt at 600° to 700° F., but a

Fig. 958.

higher temperature is necessary before the metal is ready to pour. A temperature of 900° F., however, will cause rapid oxidation, which, of course, should be avoided. An ordinary ladle may be employed to melt the alloy, which is poured at the proper temperature into the opening of the flask and investment. When sufficient time has elapsed for the metal to cool, the flask is opened and the case presents the appearance represented by Fig. 960, when it is ready for finishing, the surplus alloy being removed by a saw, and the surface of the plate polished by pumice on a wheel and brush.

To repair this work all edges are scraped clean, and a space cut between them of about one-eighth of an inch, which is filled with wax when the set is adjusted on the model. At each end of the

Fig. 959.

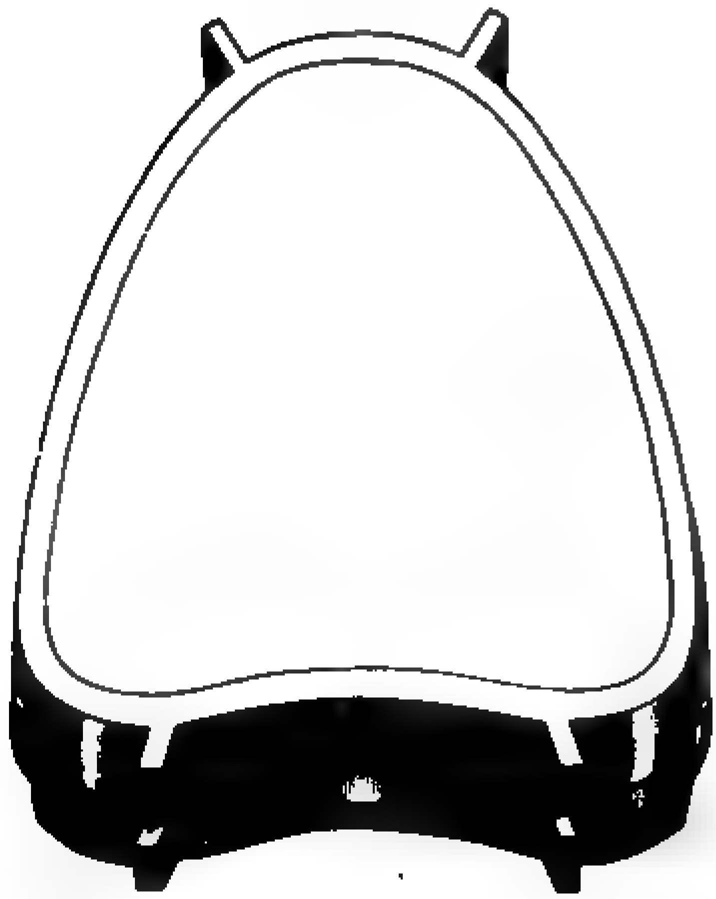


Fig. 960.

space two cones of wax, each about one-eighth of an inch in diameter, are attached, standing perpendicularly to the palatal surface, and the whole invested with plaster to the depth of an inch. The two sections thus made are then separated, and the wax is washed out by boiling in hot water. The external ends of the spaces left by the wax cones are then countersunk and a larger wax cone is inserted into each opening, the one to form a pouring-gate and the other to act as a vent for surplus metal, this last being entirely covered by the plaster of the investment. The entire piece is then invested in a repair-flask, and the plaster thoroughly dried and heated up before the alloy is poured.

Fig. 961 represents a dental mould designed by Dr. Hayford for use in manipulating Weston's, Watt's, and Hayford's alloys and by

FIG. 961.

which it is claimed all imperfections caused by air bubbles or failure of the material to cast sharply are overcome. The metal is introduced with the flask partly open, and just before crystallization commences pressure is applied by means of the lever, which closes the flask and forces the material into every portion of the mould, producing a sharp, perfect casting.

Ward's Electro-Metallic Dentures.—A process of depositing by the action of a battery gold and silver directly upon the surface of the plaster model obtained from the impression of the mouth, and thus securing perfect adaptation, has recently been introduced. The surface of the plaster model is prepared for the deposit of gold by coating it with plumbago. A definite thickness of gold is first deposited on the plumbago-covered surface of the plaster model, and upon the gold a deposit is then made of silver, which in like manner is then covered by another deposit of gold. The object of using silver as an intermediate layer between the two gold layers is to give strength to the plate, as all deposited metals are deficient in that respect, but silver less so than gold. Sometimes a thin silver

plate is swaged and the gold deposited upon it. Any desired thickness of gold can be deposited. If a rim is desired on the plate the edges of the impression are cut down and shaped accordingly before the model is poured. A plate so constructed must not be soldered, as the heat will anneal it to such a degree as to render it too pliable; hence in a set of full metal the teeth are attached by depositing gold about and around their pins, and the backings are portions of the deposited metals and continuous with the plate. This process is applicable for full and partial dentures of all metal finish and for combination with rubber or celluloid, in which case a portion of the surface of the plate—that covering the alveolar ridge—is so formed as to present projections of the metal in the form of retaining-points for securing the vulcanite or celluloid which attaches the teeth and forms the gum portion. It can also be applied to capping crowns or cusps and to removable bridge work.

VULCANO-PLASTIC WORK.

Under this name are included all vegetable materials which have been, or may hereafter be, incorporated with sulphur, iodine, or other substances, for the development of those peculiar properties so well known in hard rubber. Inspissated linseed oil, amber, and gum copal, etc., have thus been experimented with, but with results thus far very unsatisfactory. They are here mentioned because it is by no means improbable that among the vegetable oils, resins, or gums, now known or to be discovered, there will be found one which shall excel any yet known in those remarkable qualities imparted by sulphur to the resinous gums, gutta-percha, and caoutchouc. These differ from some other resins in an opacity which follows them through their combinations with sulphur, making it impossible to obtain even a tolerable imitation of mucous membrane. Possibly some as yet unknown vulcanizable transparent resin may be found carrying into its combinations enough of translucency to give that peculiar, life-like animation which now characterizes porcelain-gum colors alone. The history of caoutchouc teaches us that it is not impossible we may be in daily use of some such gum or resin. The only compounds of gum (more strictly, resin) and sulphur that have been tried to any extent are corallite and vulcanite —the trade names of sulphuretted gutta-percha and sulphurated caoutchouc; also spoken of as sulphide of caoutchouc, because the new properties developed by the union are such as make it appear

to be a true chemical compound, and not, like the vermilion, etc., often incorporated with it, a mechanical mixture.

Corallite.—Gutta-percha is the resinous exudation of a forest tree, the *Isonandra Gutta*, found extensively in Sumatra, Borneo, and the Malayan Peninsula. It was first brought to the notice of the Europeans by Dr. Montgomerie, of Bengal, in 1842, and in a few years attracted much attention for those valuable properties which have since made it so indispensable to the dentist. Twelve years ago experiments were made with it in combination with sulphur. Combined with half its weight of sulphur, and the compound then mixed with half its weight of vermilion, it formed a substance known as "Corallite," which hardened under the same conditions as vulcanite, and of which it promised to become a formidable rival.

Unfortunately, one property of crude gutta-percha followed it into this combination—its tendency to become brittle. It is well known that sheets of this substance, whether the pure crude gum or that prepared for dental use by large admixture of foreign matter, will become in time so brittle as to break almost at a touch. The vulcanized gutta-percha has the same property in less marked degree, but quite enough so to be fatal to its pretensions as a rival of vulcanite. Hence corallite is no longer avowedly used, and even its name is almost forgotten. So persistent in this injurious property that it will affect any rubber compounds with which it may be mixed. Any suspicion of the presence of gutta-percha should condemn sulphurated caoutchouc for dental use; this last-named gum, however, may be brittle and worthless from admixture of other substances besides gutta-percha, as will be hereafter stated.

VULCANITE.

Caoutchouc, formerly known as elastic resin, and still more universally known as India-rubber, was discovered by certain French Academicians in Cayenne in the year 1735. For many years its only known value was as an eraser of lead-pencil marks. Dr. Priestley, the distinguished discoverer of oxygen, in the preface to his work on Perspective, published in 1770, speaks of it as being excellently adapted to the purpose of wiping from paper the marks of a black-lead pencil. It was still many years after this that it was confined to this use and to the making of rubber shoes and bottles by South American and East Indian natives, who formed them on clay moulds from the fresh exudation of the *Siphonia cahuca Jatropa elastica*, or *Ficus elastica*. Upon discovery of a solvent, its

uses were extended by bringing to bear the skilled labor of civilization; but the fact of its becoming hard and rigid (yet not brittle) at 48° greatly limited its value. The principal solvents of caoutchouc are spirits of turpentine, bisulphide of carbon, benzol, ether, chloroform, naphtha, and the essential oils.

Mr. Charles Goodyear's discovery of the remarkable effects of sulphur in combination with caoutchouc has, since 1840, extended the application of this gum to an almost infinite variety of uses. In certain proportions and at certain temperatures the sulphur does not much impair the remarkably elastic and flexible property of the native gum, but preserves it at low temperatures. Subsequent experiments led to the discovery of hard rubber, which at first was made into combs, buttons, etc. It was thus used for a number of years before its application to dental purposes. This was first attempted as early as 1853. Mr. Bevan, a former employee of the Goodyear Company, Dr. Putnam, of New York, and Dr. Mallett, of New Haven, were the first persons known to the writer as engaged in these experiments; possibly others were at the same time thus occupied. But owing to the exceedingly cumbrous vulcanizing apparatus (Dr. Putnam's weighing twelve hundred pounds), and the absence of that knowledge of the material and those appliances for its manipulation which experience alone could give, it made very slow progress for the first few years. It has been estimated that in 1858 not more than three hundred dentists made any use of it; in 1863 it was conjectured by Dr. Franklin (then dental agent for the American Hard Rubber Company) that nearly, if not quite, three thousand employed it in their practice. At the present time, the patents restricting its use having expired, it is universally employed.

Hard rubber possesses, when prepared in greatest perfection, many qualities which fit it for use as a base plate. It is impervious to the buccal secretions and unchanged by them; it has very considerable strength, great lightness, and, when properly vulcanized, a high degree of elasticity. For some purposes in prosthetic dentistry it has no equal and for some few it is indispensable; but the merit of superior adaptation is shared by other plastic substances, and for many cases we have shown that the fit of an old-fashioned gold plate is much to be preferred.

Dental vulcanite is usually incorporated with vermilion, to give it a color more generally acceptable than the dark brown of the simple sulphurated gum. But rubber, sulphur, and vermilion are all opaque substances, and can never themselves, or by combination with other materials, be made to assume any resemblance to the

natural gum, which porcelain alone has thus far been able to imitate. The incorporation of such substances for this purpose has no other effect than seriously to impair the strength of the material. Experiments in vulcanite are much more troublesome than those with stannic alloys, and probably few will take the trouble of making them. A common formula for the red vulcanite is caoutchouc, 48 parts; sulphur, 24 parts; vermilion, 36 parts. The formula for a dark brown vulcanite is caoutchouc, 48 parts; sulphur, 24 parts; this gives the strongest rubber. The formula for a jet black vulcanite is caoutchouc, 48 parts; sulphur, 24 parts; ivory, or drop black, 48 parts. All colored rubbers are weakened by the addition of foreign matter, as English pink vulcanite, which contains 48 per cent. of white clay. White oxide of zinc in the proportion of 47 per cent. will give to vulcanite mixed with sulphur and vermilion a deep pink color. The pink rubbers are so much weakened by the admixture of foreign matter that care must be taken, when they are used to produce a more natural color of the gum portion of a denture, to prevent the pins of the artificial teeth from being covered by such rubber. From an extended series of very careful experiments by the late Prof. Wildman we condense the following statements:—

Caoutchouc two parts, sulphur one part, form a dark brown rubber, which is the strongest of the vulcanites. Of all additions for modification of color, purest vermilion is best; it withstands heat, resists the action of sulphur, and has an intensity of color that soonest overcomes the darkness of the rubber. Being a sulphuret, it appears to have much less effect in weakening the texture of the sulphide of caoutchouc than an equal quantity of any other substance; yet it does diminish its strength in proportion to its use. English deep red and American Hard Rubber Company's red contain by weight two parts sulphide of caoutchouc and one part of vermilion. To the red and brown rubbers white oxide of zinc or white clay are added in proportions varying from .20 to .57 per cent., to produce grayish-white or pink rubber. Of these the best is Ash & Sons' pink rubber (S. P.), containing gum sulphur and vermilion, in same proportion as English deep red, with one-fourth this weight of white oxide of zinc added to tone the deep color. Black rubber is made by adding to six parts of the brown sulphide from two to four parts of ivory black.

In the selection of rubbers we unhesitatingly decide in favor of the brown vulcanite, not from any absurd idea of the injurious action of vermilion, which we shall presently show to be perfectly harmless, but because of its superior lightness and strength. We are not

justified in sacrificing these valuable qualities for the sake of colors, which not only have no greater æsthetic harmony with the mouth, but which by the brilliancy of their color attract attention to this defect. We use white platinum and aluminium and yellow gold; ivory, in old times, soon darkened, and a tobacco chewer will blacken any vulcanite plate. Why not, then, use a brown base plate from the beginning? If the vermilion rubber is used let it by all means have its natural rich mahogany color, and not the glaring brilliancy with which students delight to invest their specimens. This does very well in show cases, and is eminently adapted to those captivating exhibitions of high art where a lovely wax face opens and closes, revealing alternately an aching void and acheless grinders; but in the mouth such bright colors are monstrous violations of good taste.

Vermilion combined with rubber cannot have any deleterious effect. In no case coming under our observation have we seen a single symptom of local or constitutional action peculiar to vulcanite, except a sensation of heat; this we take to be an electric action, due to the fact that rubber, like sealing-wax, is a powerful negative electric. It is common to brown, red, pink, and white rubbers, and there is no remedy for it. It is not a constant symptom; some patients never feel it, some often, some occasionally—dependent, perhaps, upon the state of the electric element entering into the composition of vital force.

Pure sulphuret of mercury is reckoned by Orfila as medicinally inert. Fumigation, by *vaporizing* the mercury, gives it a medicinal activity; but this requires a temperature of 600° Fahrenheit. Therefore, for the development of constitutional symptoms, we must have the presence of arsenic or of red lead, as impurities of the sulphuret, or the existence of free mercury.

First, as to the impurities of arsenic or red lead: they are not found in pure vermilion. But even if present such poisonous impurity would be rendered harmless, because completely invested by an insoluble coating of India-rubber. A piece of vulcanite is impervious to the fluids of the mouth; hence no part of its substance can be dissolved and thus taken into the stomach. Any supposed medicinal action must, therefore, come from such minute particles as may possibly be worn off the lingual surface near the teeth, where bread crusts or other hard particles of food impinge. White, gray, and pink rubbers have so large a proportion of foreign matter that they are easily abraded; but in the pure red rubbers we have thus an almost infinitesimally small quantity of vulcanite taken into the stomach, one-third of which is inert vermilion, adulterated

(we will suppose) with three per cent. of arsenic, and this coated with a layer of rubber, which, as previously stated, is insoluble in water, alcohol, alkalies, or weak acids. This very minute trace of arsenic, even if divested of its envelope of rubber, would have a purely homœopathic (and, by consequence, not poisonous) action; while, if encased in rubber, which pervades every part of the material, it is absolutely inert. The same may be said of the less poisonous adulteration, red lead.

Secondly, as to the mercury: the researches of Prof. C. Johnston, with the microscope, and Prof. Alfred Mayer, by chemical analysis, have failed to discover the slightest trace in samples of the best rubber used. Prof. Wildman found sulphur sublimed during vulcanization, but not the smallest trace of mercury. We have failed by any mechanical force to press out any globules, nor have we ever, in any manipulations, seen the slightest particle of this metal, or been able with the microscope to detect it upon the surface of any finished piece. This question of the presence of free mercury in the vulcanized material may perhaps require a more extended series of experiments. It is the only agent that can possibly exert any deleterious action upon the system. That its presence is rare is proven; that it is never found can be confidently asserted or denied only after the extended observations recommended, the observers, however, being careful not to confound the minute crystals of sulphur with globules of mercury, as some have done.

Impressions for vulcanite work may be taken in plaster, wax, gutta-percha, or modeling composition. The minute accuracy of plaster is not so essential in swaged work, since the very fine lines of the model are partly lost in the die and could not be impressed on the plate; but in the vulcanite the faintest scratch is faithfully copied. The finest plaster must be used and stirred until all air bubbles are removed. Although fine plaster will give the minutest lines, yet many prefer for all laboratory use a moderately coarse plaster, which becomes hard and strong when it sets, and recommend in all cases admissible plaster to be mixed as thick as it will work well, as thin-mixed plaster expands more than the thick-mixed. The fracture of the teeth of a plaster model may be prevented by inserting small pieces of wire or brass pins in the impressions of such teeth before pouring the plaster. The absolute necessity of plaster impressions, in most partial cases where vulcanite is used, led the late Prof. Austen to devise the method, elsewhere described, of taking impressions with gutta-percha cups. The advantage of a partial plaster impression thus obtained are: first, the exact shape of the outside of the teeth adjoining the space

to be filled permits correct adjustment upon the model; secondly, the accurate shape of the inside of the molars and bicuspids, at the point where wax or modeling composition impressions drag, allows the stays or half-clasps to be closely fitted to the teeth. But it must be borne in mind that partial impressions in plaster and partial pieces in vulcanite demand for their success the utmost care and nicety of manipulation, a care which the result will fully reward. The absolute non-contraction of rubber may make wax, modeling composition, or gutta-percha in some cases a better impression-material for full sets than plaster; in fact, we recommend plaster less often for full vulcanite plates than for base plates of any other material; while in partial cases, for reasons just given, we prefer its most exclusive use.

Vulcanite models require no particular shaping except the extension of the back part an inch or more, so that the model itself may serve as one-half of the articulator. This not only saves time and plaster, but gives more accurate results, since there is no transfer of the teeth and wax plate to a new wax model. When the teeth are set in the wax plate the model is then separated with a saw from the back part and placed in the flask. In double sets the back part of one model is smoothed and the T-shaped groove cut and soaped or covered with tin foil; the extension of the other model is left rough, and when the articulating plates are made the models are set into their respective plates and the space at the back part filled with plaster. Partial models containing a number of teeth require no other antagonizer than a model made from a simple impression in wax of the lower teeth, which will fit the irregularities of the teeth of the upper model. Models for vulcanite may be coated with very dilute soluble glass (liquid silex), collodion, or tin foil. The late Prof. Austen, in 1858, sent his earliest experiments in rubber to Dr. Putnam, of New York, to be vulcanized. The doctor wrote to know "what the varnish was which prevented the rubber from sticking." It was this soluble glass, used originally for the purpose of hardening the surface, to prevent injury from subsequent manipulations.

Antagonizing plates are made by moulding a piece of gutta-percha over the model, kept very wet to prevent adhesions. The central part should be not less than one-eighth of an inch thick, to give stiffness to the plate; the rim on the edge should be the exact length of the teeth required and trimmed very carefully on the outside to give the proper fullness. The gutta-percha should be first worked into a ball, using from one to two sheets, according to the size of the mouth; then, pressing from the centre outward, the articulating

rim is formed at the same time that the material is turned over the ridge. It is quickly done, will not injure the most delicate ridge, and gives a plate as unyielding as any gold plate. In a lower set the rim may be stiffened with a piece of heavy iron or copper wire. In a full or nearly full upper set the impress of the lower teeth is to be received in a thin rim of wax set on the gutta-percha. In a double set the rims are trimmed till they touch uniformly, and then their relation marked by decided indentations across the line of contact. It is quite possible with these gutta-percha plates to take the articulation in every case with such absolute accuracy that no trial of the teeth is necessary, nor any grinding of the teeth upon inserting them in the mouth. Metallic articulating plates swaged for the case are much more troublesome and are no better. The usual method of making them of sheet gutta-percha, wax, or tin foil can never give one that full confidence in his articulation which enables him habitually to dispense with the trial of the piece after grinding. As vulcanite articulations are often taken, it would be as well simply to look at the mouth and guess at them.

The modeling composition is an excellent material for a base plate in securing the articulation. After being softened and adapted to the cast a roll of softened wax is placed upon the base plate over the alveolar ridge and shaped to the form of the arch. After being tried in the mouth and added to or trimmed off if too short or too long, the patient is directed to bite into the wax. To prevent securing too long or too short a bite, one or more small blocks of soft pine wood, about half an inch square and thicker than the required bite, may be attached to the base plate with melted wax and trimmed off until the necessary length is obtained. The wax rim is then applied over the block and the proper articulation secured. For an entire denture the articulating rims may be made of modeling composition.

Preparatory to the selection and grinding of teeth or blocks the thick articulating plates must be removed and the model covered with thin druggist's foil, and the space inside the ridge filled with a mass of soft wax pressed out until it meets the probable inside line of the teeth to be fitted; this affords a much firmer support to the teeth during grinding than the usual practice of using the thin wax or gutta-percha matrix plate. The top and outside of the ridge are left covered with foil alone. When blocks like Fig. 963 are to be ground, passing over the front of ridge and surmounted with a rubber band, it is essential that the block shall not quite touch the model at any point; this contact is prevented by placing

between the foil plate and the model a strip of foil having four, six, or eight thicknesses, as may be desired. But when blocks such as Figs. 964 and 965 or teeth like Fig. 962 are ground resting directly upon the gum, with no rubber above or under the upper part of the gum, the tin foil is retained only during the process of grinding, so as to receive the paint used in accurate fitting of blocks; the foil is then removed and the plaster scraped, so as to slightly bed the front blocks or teeth in the natural gums. As the teeth are ground they should be attached to the wax mass with softened or melted wax.

FIG. 962.

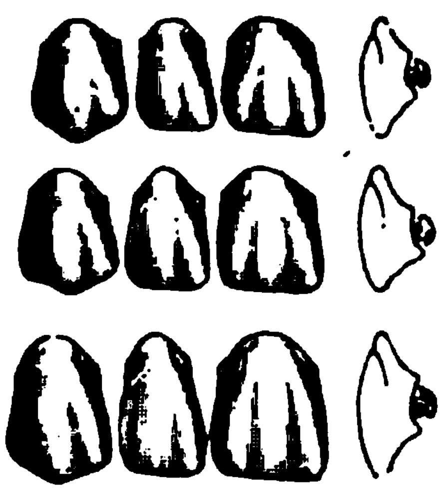


FIG. 963.

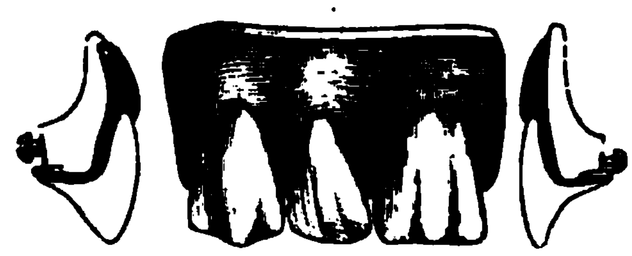
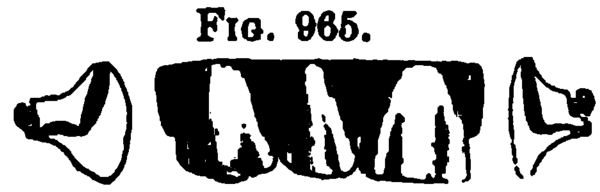


FIG. 964.

FIG. 965.



In grinding the greatest care must be taken to make close joints; but the fitting of the base requires none of the accuracy demanded in fitting gold plates, except when the tooth is to be set directly upon the gum. It is, however, a mistake to suppose that a space of half an inch can with perfect impunity be left between the teeth and plate; for vulcanite has a slight shrinkage on cooling. Unlike the shrinkage of metal, which is irresistible, that of vulcanite is controlled by the matrix, so that it results in no change in the shape of the plate. This is proved by the closeness with which it is seen to adhere to the model on opening the matrix. But it takes place in the direction of the thickness of the plate. If, therefore, a large bulk of material is interposed between the teeth and ridge, it will shrink perceptibly either from the ridge or from the teeth; in the first case impairing the fit of the piece, in the latter case loosening the hold of the rubber upon the tooth. Thick masses of vulcanite are also apt to be porous or honeycombed, owing to the evolution of sulphur. That sulphur is evolved in all cases is evident from the staining of the plaster, blackening of the flasks and inside of the vulcanizer, and from the peculiar smell whenever there is escape of steam. We sometimes find it makes the rubber porous, especially in lower cases, in spite of every precaution taken to prevent it. It is not impossible that subsequent modifications in the time

and manner of vulcanizing may correct this and several other difficulties attendant on the hardening of thick masses of rubber; meanwhile it is safer to avoid all unnecessary thickness of material. Many cases will permit the use of a stout aluminium wire behind and under the pins, running along the incisors and bicuspids; if so, it will reduce the bulk of rubber and strengthen the piece. We often run a heavy platinum wire or strip of doubled plate behind the entire arch in lower sets to add to their weight and strengthen them; when carefully done it makes a very strong piece, and removes the objection of lightness which prevents the use of rubber in many lower cases.

When the teeth or blocks are ground, and the joints and outside fitting carefully examined with a Coddington lens or some other strong magnifying glass, the next point is to make guiding grooves or holes in the plaster articulator below the teeth; then place the lead band and pour the temporary investing rim, as has been already described in the investment of teeth for gold plate preparatory to backing (see p. 970). If it is a partial piece we often prefer to make this rim with a roll of gutta-percha, previously wetting the model to prevent its adhesion. An elastic band or string will hold this rim in place while the wax is being removed and substituted by the matrix plate, that is, the wax plate which is to be replaced by the rubber. The use of the rim permits an examination of the blocks or teeth on the inner side and the correction of any irregularity in the pins or in the inner edge of porcelain where it meets the rubber, also the grinding off of any point where a block may come unnecessarily near the model.

A small roll of soft wax is then to be pressed against the pins and model, holding the rim firmly to prevent the slightest displacement of the blocks. A wax matrix plate is then slightly softened and pressed gently over the face of the model and the other wax up to the tooth. Be careful not to thin the wax unequally, and yet to press it into all the natural irregularities of the model and to bring out the tracings of the rugæ and the central raphé. If the first wax is trimmed so as to just clear the tips of the pins and have a slight curve where it joins the model, very little trimming of the wax plate will be necessary when blocks are used. This method also enables the operator to know exactly the thickness of the plate at all points. Gutta-percha does not answer so well as wax, as it cannot so readily be smoothed where it joins the blocks. After using the wax-knife around the edges it is well to go over the surface with a strip of oiled buckskin.

The wax plate should vary in thickness from No. 14 to No. 18 gauge plate (Fig. 798), according to the depth of the palatine arch. Vulcanite cannot safely be reduced to the thinness of gold or aluminium plates, or even of the best stannic alloys. The elasticity of the best made vulcanite is often thought to justify great thinness of plate, and this may be allowed in some partial pieces; but in full sets, or where many teeth lie grouped together, elasticity, with thinness such as permits bending of the plate, is very apt to cause opening of joints or breaking of blocks. Elasticity of vulcanite lessens the chance of injury from an accidental fall; but as an element of strength it is principally valuable as improving its rigidity and toughness; and the plate of all full sets should be thick enough to be unyielding under the force of mastication.

FIG. 966.

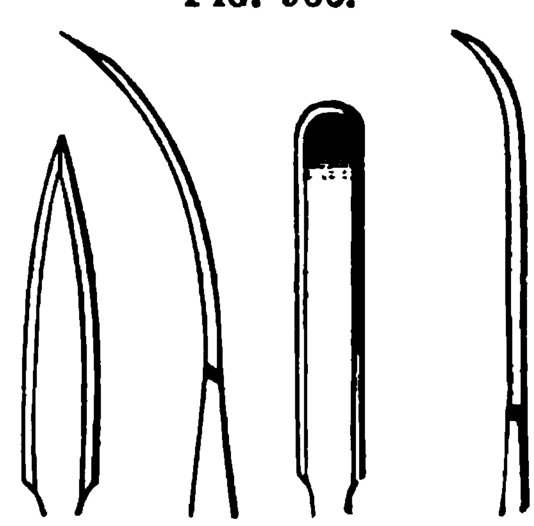


Fig. 966 represents the ends of a suitable wax spatula or knife. In flowing wax with the heated spatula around the teeth, after they have been accurately arranged upon the model, care must be taken to keep the joints free of it; and the wax plate should be fashioned and smoothed with either the blowpipe flame, benzine applied on a piece of soft cloth, or by the repeated and careful application of the warm spatula.

The wax plate should be as perfect a counterpart of the vulcanite plate as it is possible to make it. Fig. 967 represents a set of carving instruments, designed by Dr. W. W. Evans, for modeling wax in vulcanite, zylonite, and celluloid work.

When the inside wax plate has been completely finished the outside plaster rim is removed, having provided for its easy removal by a break or section opposite the incisors. Again examine all joints with the glass to see that they have not been accidentally opened; then apply one or more strips of wax to give the required form of edge, outside the ridge and above the blocks. Plain or gum teeth or blocks, resting directly on the gum, must, of course, have no wax in front of incisors, canines, and first or even second bicuspids; in all such cases be careful, just before investing in the flask, to see that the teeth set closely down upon the model. Vulcanite blocks have a shoulder designed to receive the margin of the external rubber band; when the blocks have been chosen with such care that no grinding of the upper edge is necessary, this gives the best finish. But it often happens that the exigencies of the case require

thinning or shortening of the blocks; a thin edge of wax should then slightly overlap the blocks. If the porcelain edge has sufficient thickness it is sometimes a good plan to bevel it; the rubber may then be finished continuously with the porcelain, and yet have a retaining edge. It is well to pass a very fine corundum slab over the gum just before placing the wax rim; it removes accidental roughness and makes the finishing process easier. Superfluous wax should be avoided outside as well as inside; but every undercut must be filled, else there will be danger of breaking thin or prominent ridges in separating the matrix. Outside surplus is more easily removed than inside; hence there is no objection in running the wax further up on the ridge than the finished plate; but unnecessary thickness is to be avoided for reasons before given.

Fig. 967.

If the original model has been extended for articulation carefully remove the plate and saw off this portion of the model, and trim so as to fit the half flask in which it is to be set. This trimming done, replace the plate and fasten it around the edges with a hot wax-knife. It is now ready for the vulcanizing flask.

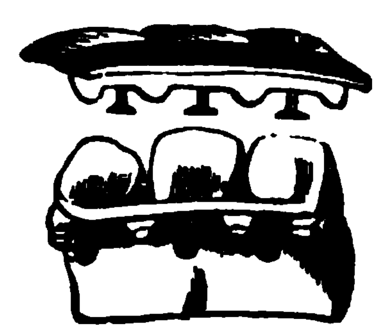
All forms of teeth may be used with the vulcanite base, and, unlike most other work, may be used again and again. Continuous-gum teeth can be strongly and handsomely arranged, provided the patient shows but little of the tooth; and also where celluloid is used in connection with vulcanite. Single teeth, plain or gum, require either to be backed with gold strips and soldered, or simply to have the pins lengthened. For this purpose heavy platina wire, say No. 20, should be cut

into lengths from one-fourth to three-fourths of an inch long, set between the pins in the required direction and soldered with pure gold. Plate teeth backed with a narrow platina strip, similar to Fig. 968, may also be used, and are required in certain cases that will not admit of thick vulcanite teeth. The projecting tang strengthens the rubber in case of isolated teeth and may be serrated with a file; but a pair of forceps with serrated beaks may do this better and more quickly than the file. Occasionally some one or more under teeth strike so closely against the gum as almost to touch; if rubber is used in such cases these teeth must be plate teeth with the usual soldered gold backing, having a serrated extension into the rubber.

The assortment of vulcanite teeth now offered to the profession is, in variety of color, size, and shape, such as to meet almost every possible case. In fact, we doubt if the manufacturer's æsthetic skill in making is not sometimes in advance of the dentist's æsthetic

FIG. 968.

FIG. 969.



taste in selecting. Certainly the stiff uniformity and monotonous expression which so frequently meet the eye is an injustice to the present high development of the dento-ceramic art. In the next chapter we shall illustrate by wood-cuts, kindly lent to us by the S. S. White Co., some of the delicate forms which so exactly imitate Nature. Figs. 962, 963, 964, 965, 968, and 969 will give a correct idea of the special form and shape of the ping of vulcanite teeth as at present manufactured.

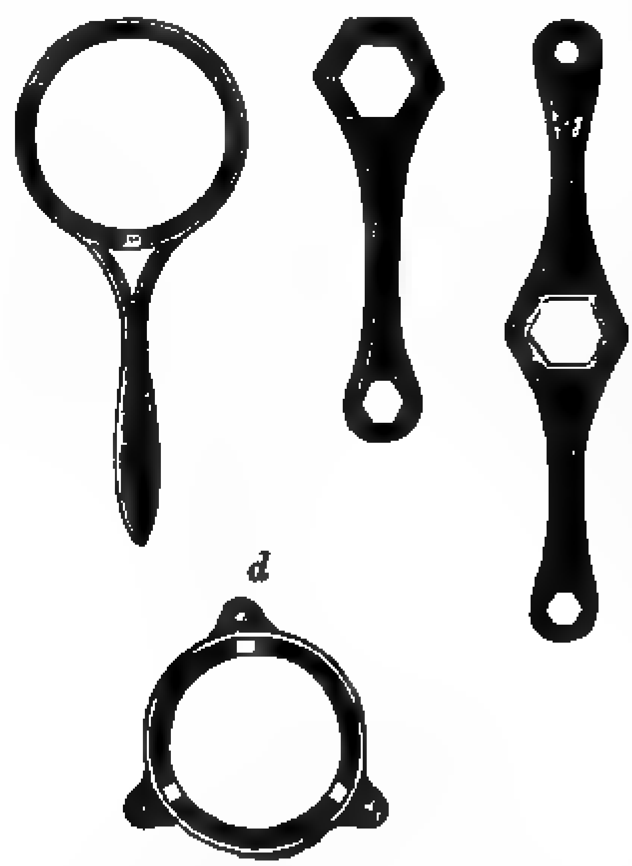
Vulcanizers.—A sixteen-horse-power boiler, communicating by twenty feet of pipe with a thirty-inch cubical steam chest, was the vulcanizer of 1857.

The first one which was at all practicable as an office fixture was a two-chambered affair of cast iron, as large as a soda fountain reservoir, heated by a coal stove. Successive improvements have since been made, and the vulcanizer of to-day is a very different thing from the huge, clumsy affair from which it originated.

The proper working of the vulcanizer and the satisfaction with which it is used depend, in a great measure, upon the perfection of the workmanship put upon it; and a saving of a dollar or two in first cost, coupled with the possession of a poorly-made machine, will prove an expensive investment in the long run.

Copper is now almost universally employed as the material from which the boiler or body of the vulcanizer is made, a ring of brass being brazed to the edge to form the packing joint and the attachment for the cover. The flexibility of these materials render it im-

Fig. 970.



portant that the cover fastening should support the whole circumference of the edge of the boiler and bring the strain uniformly upon it in order to preserve the truth of the face of the packing joint. If the strain is brought to bear upon the circumference of the joint at intervals, as when bolt or clamp fastenings are used, the result is that the boiler gradually yields to the strains at the points where it is unsupported, the joint is drawn out of true, and in a short time the vulcanizer is leaky and comparatively worthless. For this reason the screw-thread fastening has proved satisfactory.

Fig. 971.

The Whitney Vulcanizer, Fig. 970, has a very simple fastening, the cover screwing directly on to the pot. Though the joint is not absolutely steam tight the vulcanizer is capable of doing good work. It is closed by two wrenches, Fig. 970, *b* and *c*. The bed plate and wrench, Fig. 970, *d* and *e*, are pre-

ferable where attachment to a stationary bench can be had. The mistake is often made of oiling the screw of this vulcanizer fastening. The oil will burn on, causing the cover to stick and sometimes become almost immovable. A very little black lead, very seldom applied, will keep the packing joint and thread in the best condition. The error is more frequently made of doing too much rather than too little in this direction.

FIG. 972.

The Hayes Vulcanizer, Fig. 971, has a cover which is placed upon the packing joint, and is secured by a screw-collar which screws over the edge of the boiler, three set-screws in which bear upon the cover, to make the joint steam-tight. This fastening, though more com-

plicated than the "Whitney," has the merit of obviating any sliding movement on the packing in tightening the joint, thus increasing the durability of the packing, and of being absolutely steam-tight. To prevent the packing from sticking to the edge of the boiler it is occasionally dusted with pulverized soapstone.

The Hayes "Iron Clad" Vulcanizer resembles the one just described. The copper boiler, however, is covered by a shell of malleable iron, which greatly increases the strength. By a cold-water test these vulcanizers have been found to stand a pressure of 800 pounds to the inch without injury. They are very strong, and we believe there is no instance on record of the explosion of a vulcanizer of this description.

The Snowden & Cowman Vulcanizer, Fig. 972, recently introduced, and an excellent apparatus, has a fastening similar to the Hayes.

FIG. 973.

FIG. 974.

The collar has lugs upon its interior, however, engaging with others upon the boiler, thus dispensing with the screw thread.

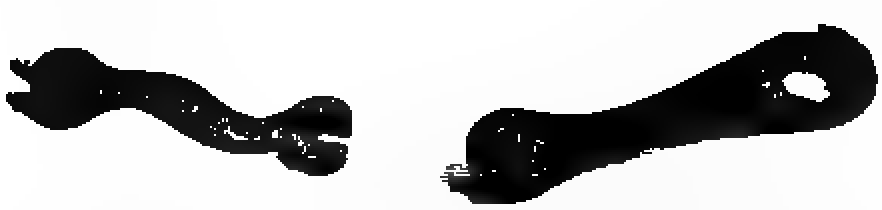
The Edson Vulcanizer, Fig. 973, and the Woodard Vulcanizer, Fig. 974, are so made that the flasks can be closed after they are put in the vulcanizer and while steam is rising. In the Edson Vulcanizer this is done by means of a screw. In the Woodard a steam cylinder and piston form part of the vulcanizer top, and the flasks

are closed by the rising pressure of the steam operating upon the piston. These vulcanizers may also be used for moulding celluloid plates.

Fig. 975 represents the Mann Vulcanizer. The lid, instead of being screwed on to the boiler, rests on a shoulder formed on the casting, and is secured by a heavy steel clamping-bar and screw-

Fig. 975.

Fig. 976.



bolt. One end of the bar is hinged to the side of the boiler, the other end being slotted to receive the screw-bolt, which is hinged to the other side of the boiler. Rubber packing between the lid and the shoulder on which it rests makes the joint steam-tight. The lid is removed by unscrewing the nut of the screw-bolt a turn or two, when the bolt drops out of the slot and the bar is turned back, leaving the lid free to be removed. This method, while it gives as perfect a fastening as the usual plan, affords very much greater

facility for opening and closing the boiler. Should the lid stick by reason of the packing becoming chilled (a common occurrence with all vulcanizers), it is easily pried off with very much less trouble than is required when the top screws on.

Another advantage is the bail, which greatly facilitates the handling of the vulcanizer, especially when hot. Thus the boiler can be opened for the removal of one case and the placing of another. The nut of the clamping-bolt is loosened a little at a time, allowing the steam to escape gradually until the bolt is released, when the bar can be thrown back and the top of the boiler raised. The bail is also useful in removing the boiler from the jacket, in tightening or loosening the screw-bolt when closing or opening the boiler, and at all times when the boiler is to be lifted. When not in use it is readily removed.

Fig. 977.

Fig. 976 represents a steam gauge, to which is connected a condensing-chamber with pipes so arranged as to form a trap. Above this trap is placed a safety-disk attachment.

This gauge can be placed on any of the modern vulcanizers hav-

ing a blow-off or safety attachment, by simply removing the cap of same and screwing on the gauge.

The "New Mode Heater," Fig. 977, invented by Dr. John S. Campbell, presents many points of difference when compared with other vulcanizers. It is made of phosphor-bronze, in a single casting, with two chambers, the one in which the flask is placed being surrounded by an outer steam-chamber. It has screws for closing the flask as it is being heated, and is adapted to working celluloid as well as for vulcanizing rubber. Steam may be admitted to the vulcanizing chamber or not, as may be desired, and either "wet" or "dry" heat used. The use of the New Mode Heater it is claimed will prevent the rubber, when being vulcanized, from shrinking from the teeth, and also permit of the use of plain teeth with rubber for the base and celluloid for the gum, a form of work to which the name of "New Mode Continuous Gum" has been given by Dr. Campbell, the inventor (see Celluloid).

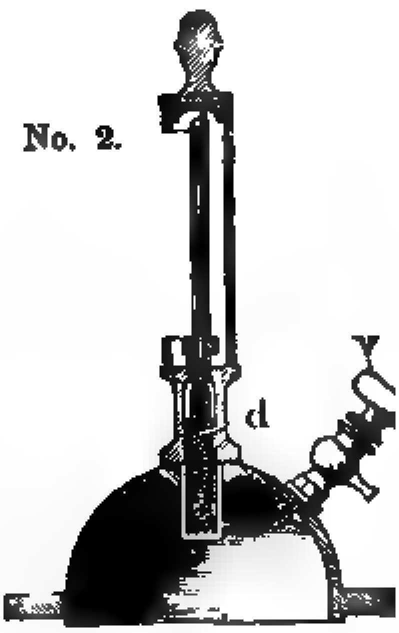
Fig. 978 represents a transverse vertical section of Dr. Frederick W. Seabury's improved vulcanizer and celluloid press combined in one apparatus, which, it is claimed, accomplishes results never before attained in the manipulation of both rubber and celluloid, and in less than half the time usually required, and a perfect success assured every time. With this apparatus cases can be removed from the oven and others inserted at any time during the process of vulcanization, with a delay not to exceed five minutes, which is a great saving of time, especially with repair work. The drawing also represents the improved flask used in this apparatus for the purpose of uniting artificial teeth to artificial gums under pressure, which is provided with guide and locking pins, the former inclined at such an angle that when the upper part of the flask is forced down to imbed the teeth into the gums it will be moving at such an angle as to allow the projecting alveolar ridge to reach its final position without breaking the plaster investment; these guide-pins can also be quickly moved from the flask by a partial rotation of the pin. The locking-pins are so placed that the upper part of the flask is forced on the lower part; the lock-pins may be forced into place and thereby lock the flask. The cover is secured by dovetail lock-pins and can be easily removed. In the drawing of the apparatus No. 1, A represents the hollow body of the vulcanizer, which is supported on the legs *a*. Within this body is placed the boiler B, which is formed with the central inverted truncated conical flue C. The boiler and flue are supported by the tubes d, which are connected at one end to the top of the boiler and at the other end to the chamber d^8.

D designates the oven, the lower end or base of which extends somewhat downward into the upper end of the flue C.

The upper end of the oven is formed with lateral flanges d[1], which rest upon the top of the case or body A, and thus support the oven in position, and also form the top of the vulcanizer.

Fig 978.

No. 2.



No. 3.

E designates the pressure-cover of the oven, which is secured in position by bolts as shown.

e e designate presser-screws, which work through square threaded sockets in the cover and press upon the flask F, in the oven, supported upon the disk m.

E[1] designates two lids, which are pivoted upon the cover in such

manner as to be readily removed, and by uncovering apertures in the cover permit visual access to the interior of the oven.

G designates a valve, which is situated in the flange d^1 of the oven, so as to close the channel d^2, leading from the pipe d to the interior of the oven.

H designates a spout; the outer end of it is tightly closed by the cap h, which leads into the tube I, entering the chamber d^3 from above. The purpose of this spout is to convey water to the boiler B.

i designates a pop safety-valve, which is seated on the upper end of the tube I. J designates a steam-gauge connected by the siphon cock j to the chamber d^3, into which the tube d opens.

K designates a test-cock communicating with the chamber d^3, and b designates a similar cock communicating with the boiler B on the water level.

In using this vulcanizer a gas or gasoline burner is set beneath the boiler B, and the valve G is closed; but the test-cock is not closed until the escaping steam shows that all the air is out of the boiler. The heat from the burner will ascend through the flue C, and will act directly upon the bottom and sides of the oven, thus heating the oven and water which has been previously placed in the boiler at the same time or separately.

No. 2 illustrates a vertical section of the solid cover which is used at all times, except when closing the flask, and occupies the same position on the vulcanizer as the pressure-cover E. It is provided with a very sensitive thermometer, immersed in a mercury bath d, which projects into the oven D, and a test-cock v, used to let the air out of the oven before vulcanizing, and to blow the steam out through after vulcanizing.

The bar wrench is to be used on the cover bolts only, and must never be used on the presser-screws e e, for which the T wrench is provided.

Figs. 979 and 980 represent Dr. W. W. Evans' New Vulcanizer and Celluloid Apparatus combined, which is claimed to possess superior qualities for vulcanizing rubber and moulding celluloid and zylonite.

Fig. 980 shows a front elevation with top attached and tools needed in the working of this apparatus.

Fig. 979 illustrates a transverse vertical section with one flask in position. A is a light casing, B the boiler, composed of two separate cups b b, united concentrically by screws b^1 to form a water and steam space. The bottom of the boiler A is partly concave to facilitate ebullition and keep the steam in a state of agitation. D illus-

trates the oven composed of the inner cups b, having a cover. C is an inlet for steam, d, through the cup b, from the boiler, and an exit for steam through the cover d^2, both openings being controlled by valves d^1 and d^3. E E represent the bolts with spherical heads at c, the point of contact with the cover C, which has a corresponding socket to receive it, thus making a steam-tight joint. The top of the head c^2 is made to fit the T wrench, that also fits the different valves. To gain more pressure than is usually required an additional sexangular portion c^1 has been made, whereby any amount of pressure can be exerted. The lower portion of the bolt is threaded for one-half its distance, and screws into or through the platen F,

FIG. 979. FIG. 980.

which is drawn toward the top by turning the bolts to the right, thus closing the flasks G with facility and without any strain upon the boiler. f is the thermometer, on either side of which are the valves, one connecting the boiler with the oven; the other a conical safety valve, so arranged that the steam in the boiler can never go higher than the point at which the safety valve is set. I is a handle to remove the top. Two large flasks may be used at a time, and it is claimed that it will readily stand from 250 to 300 pounds pressure. It is also claimed that rubber vulcanized in this apparatus is much more elastic, denser, and tougher, and retains its color better than by other processes, and that it will not shrink from the teeth, and

can be vulcanized in thicker masses without becoming porous. For celluloid and zylonite better results, shorter time of moulding (one hour and a halt), and no lost steam from the boiler are claimed.

Fig. 981 represents Dr. F. W. Seabury's Dry-Steam Vulcanizer. It consists of a boiler with a steam-gauge above and a plug in the

Fig. 981.

top through which to supply water, connected by a globe valve to an oven or vulcanizing chamber, which has a capacity for three flasks. The blow-off cock is in the centre of the cover.

An axiom of rubber manufacturers is that the drier the steam the denser, tougher, and purer color the product will be.

The advantages claimed are :—

Saving in rubber—the plates being sufficiently strong when made half as thick as they are required to be now.

Saving in time—the plates are vulcanized and finished in less than half the time now consumed.

During the process of vulcanizing cases may be removed from the oven and others inserted with a delay not to exceed five minutes.

The flasks are in a dry, clean oven; the plaster, not being immersed in water, remains intact. The plates are thereby prevented from warping, and therefore fit perfectly. The essential thing when vulcanizing is to have instantly and retain a pressure equivalent to the temperature. To insure this a steam-gauge is provided.

The mercurial thermometer has been almost universally employed to indicate the temperature of the vulcanizer. It is a simple and convenient device, and when protected from the action of steam upon the glass bulb by immersing it in the "Mercury Bath" (the invention of the late Dr. Geo. E. Hayes) it has a fair durability. If accidentally broken it can easily be replaced at a small expense. It must be remembered, however, that it only indicates the temperature of its bulb and the parts immediately surrounding it, which may be different from that of the interior of the vulcanizer. If a thermometer and steam-gauge are attached to the same vulcanizer, a discrepancy of as much as twenty degrees will be found at times in their indications, varying with the amount of air included in the vulcanizer in closing it. This statement is proved by the fact that when the air is expelled by blowing off a little steam the gauge and thermometer will always agree.

The uncertainty as to the results attained in different vulcanizations is thus accounted for. To obtain uniformity the air must be expelled from the vulcanizer. If there is no cock for letting off steam the vulcanizer should only be closed after the water in it is boiling, the cover being placed loosely upon it and allowed to remain so until steam issues freely from under it. The joint should then be tightened as expeditiously as possible. There being now an atmosphere of pure steam above the water in the vulcanizer, the heat will be equal in all parts of it, and the indications of the thermometer will be correct.

Care should be taken that the mercury bath has enough mercury in it to insure contact with the bulb of the thermometer; an air space between the bulb and vulcanizer cover will be as fatal to correct indications as in the former case.

A steam-gauge would be a very desirable indicator of the temperature if it were not for its first cost and the annoyance caused by the necessity for its connection to and removal from the vulcanizer each time it is used.

The vulcanizer is usually heated by either gas, alcohol, or kerosene. Gas, if used in a burner which will mix the proper quantity

of air with it before burning is the most convenient, cleanest, and probably the cheapest fuel for the purpose. The flame should be a clear blue, with no streaks of yellow. A yellow flame results from an insufficient mixture of air, and makes smoke, soot, and a bad smell from the production of acetylene. The use of gas also admits of the employment of the gas regulator (Fig. 982), an attachment which automatically keeps the temperature of the vulcanizer at the exact point required. The steam pressure acts upon a valve to control the flow of gas to the burner, lessening the flow as the pressure rises and keeping it at the point for which it is set. It is not liable to get out of order and with it the supervision of the

FIG. 982.

dentist over the vulcanizing process is not required; and if the time cut-off is also used the dentist is at liberty to go to his patients in the operating room without the necessity of giving a thought to the vulcanizer, knowing that the temperature will be kept exactly right and that the gas will be turned off at the right time. The results will thus be uniform; much more so than is possible with the use of the thermometer, as the regulator, operating by steam pressure, is more sensitive and exact than the thermometer can possibly be. After gas the alcohol flame is preferable for vulcan-

izing purposes. It is clean and inoffensive. Many use the kerosene stove, but taking into account its smoke and smell it may be doubted whether the economy secured by its use is not dearly bought.

The following tables, carefully collected from experiments of the French Academy, the Franklin Institute, Ure, Dalton, and others, will serve as a guide in the use of either the steam-gauge or the mercurial thermometer:—

No. 1.					No. 2.	
Pressure per Square Inch.			Temperature.			
Inches of Mercury.	Atmospheres.	Pounds Avoirdupois	Scale Fahrenheit.	Differences.	Pounds.	Temperature.
30	1	15	212°	38°	63	300°
60	2	30	250°	25°	73	310°
90	3	45	275°	19°	80	315°
120	4	60	294°	15°	87	320°
150	5	75	309°	12°	95	325°
180	6	90	321°	11°	102	330°
210	7	105	332°	10°	110	335°
240	8	120	342°	10°	117	340°
270	9	135	352°	8°	124	345°
300	10	150	360°	14°	131	350°
360	12	180	374°	13°		
420	14	210	387°	11°		
480	16	240	398°	11°		
540	18	270	409°	10°		
600	20	300	419°	9°		
660	22	330	428°	8°		
720	24	360	436°			

These tables show the increase of steam pressure with the temperature up to a point much higher than the dental vulcanizer should ever be called upon to bear. The second table is prepared especially to show the pressure due to the temperature at different vulcanizing points, and attention is especially called to the rapid increase of pressure with equal increments of heat as the temperature rises. The last column in Table No. 1 shows the additional temperature required for equal increments of pressure, and it will be seen that while it requires 38° to raise the pressure 15 pounds at 212°, only 4° is required for the same increase from 430°. The pressure nearly *doubles* with the addition of each 50° of heat, and allowing a vulcanizer to run up to 400° or 420° is shown to be a piece of unpardonable carelessness and a proceeding fraught with the greatest danger to life and property.

Every vulcanizer should be provided with some means by which the steam will be allowed to escape before the danger-point is reached. Safety-valves have been thoroughly tried and have proved unsatisfactory from their constant leakage. The fusible plug, consisting of an alloy of soft metal filling a hole in the vulcanizer, which would melt and blow out at 350° or 360°, was at one time much used, but it has the fatal defect of hardening after repeated heating, so that its melting point is raised to 400° or even more; so that after being used a short time it is wholly untrustworthy. The most satisfactory device for the purpose is the copper disk (Fig. 983), made of metal thin enough to give way under an extreme pressure. It is secured upon the end of a small stud, screwed into the vulcanizer cap by means of a washer and screw-cap. Long use does not impair the efficacy of this device, and no instance has yet occurred of an explosion where it has been applied to the vulcanizer and was in good order. Strange to say, there are those foolhardy enough to deliberately plug it up and destroy its usefulness, because it has given way and warned them of their carelessness.

As the copper disk gives way from over-pressure, it sometimes does so before the thermometer has reached 320°. If this is the case, it is probably because the vulcanizer has been filled too full of water. Allowance should always be made for the expansion of water by heat; and at least one inch in height should be left, when the vulcanizer is filled, for expansion and for steam-room. An instance is on record of a Whitney vulcanizer with the fusible plug being stretched by successive heatings when full of water, so that its diameter was increased nearly a quarter of an inch. In doing this it was subjected to a strain of nearly 500 pounds to the inch and without heating it above 320°. The blowing out of the disk at an apparently low temperature may occur from applying a strong heat to the vulcanizer when it has very little water in it, the water absorbing the heat, and the pressure rising before the heat is conducted to the thermometer so that it can give the correct indication. All experiments in vulcanizing show that the best results are obtained when the temperature rises very gradually, and with some samples of rubber, and especially if some parts of the plate are unusually thick, a rapid heating is sure to cause spongy, porous places in the plate and necessitates its being made over. Repeatedly tightening and loosening the cap upon the disk, as by using it for letting off steam, will cause its failure; or tightening it with too much force. It is only necessary that it should be steam-tight; and the copper is so thin and delicate that unnecessary force will damage it.

Flasks.—Of flasks there are several varieties, many of which are open to some objections. The essentials of a good flask are: 1. It

FIG. 984.

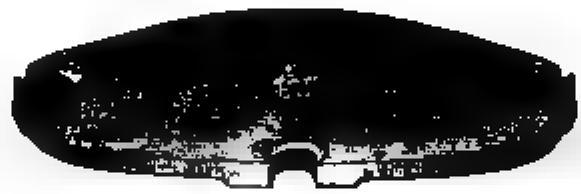
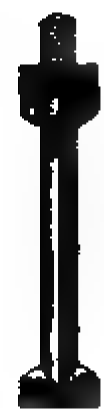
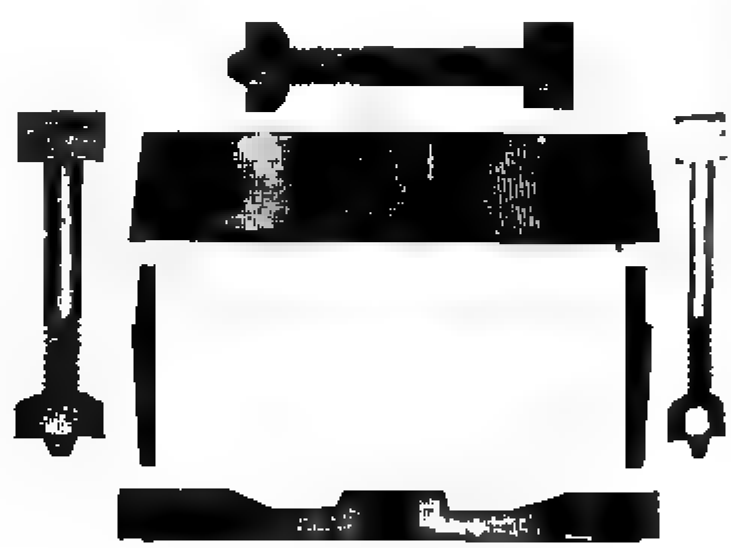


FIG. 983.



must have depth and width for the largest cases. 2. Both ends should be separate for greater convenience of placing the model in

FIG. 985.



either ring. 3. The guide-fingers, about one-quarter of an inch long, should work straight and true, be strong, and yet not unnec-

essarily break the regularity of inside and outside surfaces; cover flanges may be very short. 4. Inside and outside should present as unbroken a surface as possible for facility in removing and cleaning off surplus plaster. Both rings should taper, partly to give greatest breadth to the line of junction, partly for easier delivery of plaster.

Figs. 984 and 985 represent the "Star" and "Anchor" flasks, the first being reversible; other flasks are also self-locking by means of flat springs on the outside of the lugs.

Fig. 986 represents the "box flask," designed for extra large cases, splints for fractures, artificial palates, etc.

Fig. 986.

Making Matrix, Removing Wax, and Packing the Rubber.—The model of a full set is placed in the shallow half, A, of the flask (Fig. 987), with wax plate and teeth attached, as before described. The model must be saturated with water, to prevent the too rapid setting of the plaster batter with which the flask is partly filled, and which, on placing the model, rises to the edge of flask and edge of the wax plate. The plaster should be mixed as thick as will pour readily and the lower section of the flask partly filled with it, when the model and teeth should be placed in it, bottom down, as shown in Fig. 987, A, and slightly inclining in front so as to exclude all air bubbles when forcing it into place. In the case of an entire upper or lower set the plaster should extend up to the wax, as this will allow the teeth to be imbedded in the plaster filling the upper section of the flask. As soon as the plaster has become moderately

firm trim smoothly up to the model with spatula or sponge; then soap this surface, or varnish and oil it, or cover it with tin foil. When shellac varnish is used, care should be taken that the teeth or gums are not coated with it. Some prefer the soap solution, white soap, ℥j, soft water, Oj, for separating plaster surfaces. Some are in the habit of placing the lower half of the flask in water, that it may absorb as much as possible before the upper half is poured. Mix a fresh lot of rather stiff batter, and brush it carefully over the wax and into all the interstices of the teeth. Then place the upper half-flask, C, accurately upon the lower half, and quickly pour the batter, stirring it well with a feather or small brush, into the space between the teeth and sides of the flask. Set on the cover D and apply the clamp B, or a heavy weight. Before it fully hardens wash off the plaster with a sponge from the outside of the flask, and let it get quite hard before separating the two halves. The object of making the batter stiff is to give it greater hardness for support of the blocks under pressure of packing. These are often displaced

FIG. 987.

and the joints opened under moderate pressure; because, first, the batter is too thin, and, secondly, time is not allowed for it properly to harden before packing. The flask should be set in water at about 120° for five minutes before separation, so that in case of undercut or of a thin or prominent ridge there shall be no danger of breaking the model. Dry heat may also be used to separate the flask, but the wet is preferable, as the former may melt the wax and cause it to be absorbed by the plaster; and if the base plate is gutta-percha it will, if made too hot, adhere to the model. The wax or gutta-percha model plate should be removed entire if possible, and also the wax around the pins, by means of a small excavator, and what remains may be washed away by pouring over the surface a stream of boiling water from a height of about one foot. All wax should be carefully removed in order to prevent deterioration of the rubber, and as much of it as possible be preserved for the purpose of determining the quantity of rubber necessary to use in packing the piece. After the wax is entirely removed vents or gates are cut in the

plaster surface of the investments, as shown in Fig. 991, to allow the excess of rubber to escape when the flask is closed. The flask will then present the appearance shown in Fig. 988; the model-half, E, separating from the teeth and wax contained in the dental-half, H. Should the joints not be very closely fitted, place a little dry plaster over each and touch with a drop of water or diluted soluble glass, and when hard trim off the surplus plaster. Some prefer to pack with tin or gold foil. The zinc cement in the form of the oxychloride or oxyphosphate is also serviceable, and when used for such a purpose should be mixed quite thin and allowed to become as hard as possible. Without some such precaution the rubber will press into open joints and present an unsightly appearance; of course, closely-ground joints are preferable to any of these expedients; but

Fig. 988.

neither the tightest joints nor any precautions will avail if strong pressure is used in packing, for this invariably opens the joints and admits the gum.

In partial cases, or where no vulcanite is required outside the arch and above the teeth (where plain teeth are used, resting directly upon the gum), the deep half, H, must be used for the model and the line of separation be made at the cutting-edges of the teeth, so that the plaster around the teeth may come nearly or quite level with the edge of the flask. The teeth are thus firmly fixed in their exact position and resist displacement, which the separation of the flasks or the pressure of the rubber might possibly occasion. In this way, should the flasks chance not to come perfectly together, the result will be an extra thickness of plate, but no displacement of teeth. We consider this use of the deep-half of the flask in all partial cases as of the utmost importance. The teeth are never disturbed in their position on the model given them in the wax plate; also, there is no breaking of plaster teeth or splitting of the model by pressure of the rubber.

To prevent the rubber from adhering to the surface of the plaster model and mould, which gives a rough surface to the palatine por-

tion of the plate, this surface, as before remarked, should be coated with either liquid silex, collodion, or tin foil. When liquid silex is used, a thin coat upon a moist plaster surface answers best; collodion is applied like liquid silex; tin foil is attached to the plaster surface by means of shellac varnish and carefully adapted by pressure with a soft cone of leather to all the inequalities, and its surface is coated with collodion, which is allowed to dry, when it is again coated with the soap solution. Such a method will render it easy to remove the tin from the vulcanized rubber and give a polished surface. Without such precaution the use of muriatic acid may be necessary in order to remove the tin foil. Gilding the surface of the model with gold foil is also done.

Clean hands and instruments are very necessary in packing rubber, otherwise the color and even the texture of this material are

Fig. 989.

impaired. The mould as well as the rubber should be warm during the packing process, and the latter should be cut in different sized pieces, using a large piece of the proper shape to cover the palatine surface of the model, and which may be applied by pressure with the thumb and fingers, first dipping them in water. Fig. 989 represents a boiler suitable for heating the flasks, and having a flat top on which the rubber may be softened. In packing the smaller pieces of rubber, and especially the long strips suitable for the rim of the plate, care is necessary that all particles of plaster be excluded, and also that too much rubber is not pressed against thin margins of the gum; otherwise fracture of the porcelain blocks

may result when the flask is being closed. It is safer to pack the rubber thicker in the centre, and as it yields to the pressure it will flow around weak points without danger of fracturing them. Each piece of rubber as it is added should be consolidated; and if any tooth or block has become loosened in the plaster a drop of liquid silex placed in the bottom of its plaster cavity will, after it becomes dry, hold it firmly in place.

It is desirable in all cases and quite essential in most that the flasks should come perfectly together. This is accomplished by attention to three points: 1. Softening the rubber; 2. Using a proper quantity; 3. Having vents for the surplus. First, for softening the rubber use a deep covered saucepan capable of holding the flask-press and containing two or three inches of water. When the flask is thoroughly heated by the steam, the rubber is placed over the cover of the saucepan or on a small shelf attached to the inside of the saucepan; then while soft let it be packed with the help of a pointed stick or the smooth end of a straight excavator flattened for the purpose into the dental half of the matrix. Around the teeth the rubber may be packed in the form of very narrow strips, somewhat as foil is inserted into the cavity of a tooth, with instruments made from excavators with blunt points bent at a right angle. The remainder is packed either in large strips or in one piece cut to the shape of the wax plate.

Secondly. It is important to use the proper quantity of rubber; too little vulcanite spoils the piece; too much requires a pressure which may break the blocks, displace the teeth, and force rubber into the joints, or else requires a long time for a safe degree of pressure to bring the flask together. In some cases the quantity can be correctly found by having the sheets of vulcanite exactly as thick as the wax plate, removing the latter as carefully as possible, and marking off its size on the former. But for some irregularly-shaped cases and most lower cases the following simple method will be found better. Let the plate be entirely of wax; remove it all from the matrix and roll it into a sheet the thickness of the rubber; make the rubber a little larger than the wax; then cut into conveniently-sized strips and pack, putting most at those points where the wax was thickest. Starr's measuring glass, which determines the quantity of rubber by "displacement," is a convenient instrument for this purpose. (Fig. 990.)

For ascertaining the quantity of rubber required for any given case: The vessel being about half filled with water, set the lower pointer to the level of the water; throw in every particle of the model plate; set the upper pointer to the rise of the water; empty

the vessel and again fill with water to the lower pointer; add a sufficient quantity of rubber to cause the water to rise to the upper pointer and there will be just enough to fill the mould. Allowance can then be made for surplus.

Thirdly. Since the error in quantity should always be on the safe side of excess, provision must be made for the escape of this surplus

Fig. 990

by cutting vents, that the halves of the matrix may come together without too great pressure. Fig. 991, taken from Prof. Wildman's monograph, is a fine illustration of the best method of cutting these vents. The radiating vents might, however, stop at the circular groove, taking care to make this large enough for any possible excess of rubber. If these leaders are too large next the plate the rubber may not pack so firmly as is desirable; also the generation of gas while vulcanizing may force rubber too freely into the groove, and so make it porous.

A good form of flask press is that of Messrs. Snowden & Cowman, Fig. 992. As soon as the rubber is packed the halves of the flask are carefully brought together, placed in the press, and a moderate force applied; the press and flask are then placed in the heater. A piece of pure "rubber-packing," about an inch thick, placed under

FIG. 991.

the screw, will, as before stated, insure a constantly acting force whilst in the heater. Avoid using the full power of even one hand upon the lever; if the vents are free and great excess of material is avoided, moderate pressure acting steadily in the heater will safely bring any flask together in from ten to forty minutes.

Fig. 993 represents Dr. Donham's Spring Clamp, which utilizes the tension of a spring for closing the flasks in vulcanizing. It gives continuous pressure and dispenses with flask-bolts.

In all cases use a flask press first and the small screw bolts, except in the Donham clamp, when the case is ready for the vulcanizer. If pressure is applied suddenly, before the rubber is sufficiently plastic, there is great danger of fracturing the teeth, especially sectional blocks. When the screw bolts alone are used to bring the sections of the flask together, no more pressure should be applied

at first than can be made with the fingers, after which the flask is placed in boiling water for a few minutes, when a gentle turning of the screws will suffice to bring the parts together. Clean flasks are essential to successful packing, for soiled fingers stain the rubber, which interferes with perfect union of the pieces; hence all apparatus handled in packing should be so simple in form as to be readily cleaned; also, it is well to keep them constantly covered with a coating of varnish.

Dr. T. F. Chupein, referring to some valuable suggestions of Dr. Geo. B. Snow concerning the Physical Properties of Vulcanite, says:*

FIG. 992.

FIG. 993.

"The writer, after giving many good points and making many valuable suggestions about vulcanite work and the behavior of vulcanite dental plates, recommends that when from the nature of the case it is found impracticable to make the plate of equal thickness, the places where the plate will be unduly thick be filled with small pieces of rubber which has been already vulcanized (an old rubber plate, for example, cut up and cleanly filed into small pieces about the size of duck-shot), to compensate for the undue thickness of the plate at these points and to control the expansion or contraction of the material.

*Physical Properties of Vulcanite, *Dental Cosmos*, Aug. No., 1888.

"If a set of teeth be waxed up and flasked in the usual way, it will be extremely difficult to know where to place these pieces of vulcanized rubber; the memory being the only guide as to where they are to be put, the procedure is reduced to guess-work.

"To overcome this difficulty (recognizing the value of the suggestion) we proceed as follows: After the case has been waxed up as usual, whether gum section or plain teeth are used, the wax is carefully removed from the front part of the sections or from the front part of the plain teeth, so that these are held in place only by the wax on the palatal surface. Those parts of the sections or plain teeth and the plaster model are then painted with rubber solution (red rubber dissolved in chloroform), and when this dries small pieces of red rubber are packed next the sections to form the rim;

FIG. 994.

or small pieces of pink rubber are packed next the plain teeth to form an imitation of the gum. This being done, the case is flasked so that the plaster of investment is brought all over the front part of the teeth as shown in the figure. Thus the small pieces of vulcanized rubber may be placed just where they are needed to compensate for the extra thickness or volume of rubber at these points.

"Fig. 994 indicates the extent of such extra thickness under the bicuspids and molars, for which spaces the vulcanized pieces are to be prepared in the present instance.

"Incidentally it may be observed that by this mode of flasking the teeth are kept in their exact positions relatively to the cast, and, the gates being freely cut in the other part of the flask, the articulation will be found undisturbed even though the flask should not have been accurately and completely closed.

"It is well to say that in removing the wax from the front part of the case this should be all removed before the case is painted with rubber solution, and the small pieces of red or pink vulcanite that are put in place of the wax that was removed should be added to the

painted surface with a clean wax spatula, free from all grease, wax, or dirt, and heated (for easier manipulation of these pieces) in the blaze of a spirit-lamp. If there is any grease on the spatula the rubber will not stick to the places where it is wanted."

Time of Vulcanizing.—When the halves of the flask are brought into contact it is taken from the press, the screws are adjusted, and it is placed in the vulcanizer, which is then filled two-thirds full of boiling water, the cover adjusted, the gas or lamp lighted, and time reckoned from the moment of closing the cover.

The time occupied in heating up and vulcanizing varies with different varieties of rubber from fifteen minutes to an hour and a half. As thermometers vary much, and the rubber used also varies, the best plan is for every one to vulcanize trial pieces until the required hardness, toughness, and elasticity are obtained. It should curl under the scraper like horn, permit bending at an angle of at least 45°, and return to its original shape unchanged.

When the heat is too great, or the time too long, the rubber becomes dark and brittle. For the black rubber a longer time is necessary than for the red rubber, and the best method is to heat up very slowly until it has reached 320° F., or to use a less heat and longer time. The more foreign matters rubber contains the less time is required to vulcanize it; and where the adulteration is considerable, as in the case of the pink rubber, the heat may be raised more rapidly, but such rubbers are weak and unfit for forming any more of the plate than the gum portion. In using the red rubbers the heat should not rise higher than 320°, and the piece should be allowed to stand until it is cold.

In a very large proportion of vulcanite pieces the full strength of the material is lost by overheating; in others by the opposite error of giving too much elasticity and throwing undue strain in full cases upon the blocks and the rim of rubber behind them. If some of the time spent in polishing up vulcanite and bringing out the offensively glaring brilliancy of its color were devoted to careful management of the vulcanizer, to making proper record of heatings, so as to arrive at uniform results, and to the cultivation of those habits of accuracy which alone can give success, there would be fewer broken pieces returned to the laboratory for repair.

Slow heating and a perfectly tight vulcanizer full of water, with flask well bound together and vents not too free, are the best safeguards against porous rubber, except where an unusual thickness is required, when the small pieces of hard vulcanite may be used in packing.

It sometimes happens, when large and thick masses are built upon

the plate, as in cases of excessive absorption, that the thick portions of the plate, when vulcanized, prove to be soft and spongy in the centre. This is the result, first, of bringing the plate up to the vulcanizing point too quickly and the retention of the sulphurous gas. A long time, even two, three, or four hours, the time depending upon the thickness of the mass of rubber to be hardened, should be taken to raise the temperature of the vulcanizer from, say 250° to 320°, if no pieces of hard rubber are used in packing. Second. Different samples of rubber act differently when vulcanized in thick masses, depending somewhat upon the amount of earthy matter contained in them. It is very difficult to vulcanize a mass of pure rubber and sulphur even three-eighths of an inch thick and insure its solidity. On the other hand, some of the English pink rubbers, which contain large amounts of oxide of zinc and vermilion, can be vulcanized in thick masses with but little trouble. It is to be remarked, also, that rubbers which are "loaded" with earthy matter have less shrinkage than those which are purer.

So the expedient may be resorted to of packing the inside of thick portions of the plate with some one of the rubbers containing more earthy matter than those usually employed, or using the same pieces of hard vulcanite as before described. The expedient of filling in parts of the mould where the thickness of rubber is excessive with a mixture of small fragments of old vulcanite and new rubber will answer every purpose as a safeguard against porosity. If the pieces are freshly filed all over their adhesion with the new material will be perfect, and the plate will be as strong as though wholly of new material.

There seems to be a point beyond which, if rubber twice passes, it becomes inevitably brittle; hence no confidence can be placed in the old material of a repaired piece. Two flasks in the same vulcanizer cannot give the same results; loss of heat by radiation is greatest from the cover, and the supply of heat is from below; hence, necessarily, the lower half of the oven is hotter than the upper. Uniformity of texture can be obtained, therefore, only by vulcanizing one piece at a time. One who is systematic in the arrangement of his work will separately vulcanize the pieces of a double set in very nearly the same time required if both are done at once; for one piece may be in the oven while the other is in preparation for it.

Removal from Vulcanizer and Finishing.—Upon expiration of the time determined upon the flame is to be at once extinguished; the vulcanizer may be cooled gradually as it stands, or rapidly by the escape of the steam, or by setting the lower three-fourths of the vul-

canizer in cold water. The last method of rapid cooling is preferable, running the heat five minutes longer than when slow cooling is practiced. Letting off steam is a very disagreeable process and makes the plaster of the flasks very hard to cut out. Flasks may, with perfect safety, be cooled by setting the vulcanizer containing them in snow or pounded ice if desired; but in no case should the flasks themselves be cooled by contact with cold water, as some might chance to penetrate to the blocks and crack them. The flask should be opened and the piece removed from its plaster investment within two or three hours after vulcanizing. After that time the plaster assumes a sand-like, granular state, and adheres with great tenacity to the plate, no matter what separating varnish may be used. Tapping the edges of the flask after separation will dislodge their contents in mass; the plaster can then be trimmed from the piece, taking care that it is perfectly cold. The adherent plaster in the dental half of the flask can easily be washed from the piece with a stiff brush; but the model half leaves a coating that clings very tenaciously, unless means are taken to prevent it; soluble glass, a dilute ethereal solution of collodion, or a layer of thin foil have been already mentioned as the proper preventives.

The process of finishing is more troublesome than in the case of gold work, unless great care is used in the formation of the wax plate. Several sizes of round and half-round files are necessary for finishing up the edges and convex surfaces; for the concave surfaces, scrapers, graving chisels, and curved files. Fig. 995 represents common forms of rubber files.

Fig. 996 represents several sizes of a form of scraper or finisher, suggested by Dr. Kingsley, with convex back and thin edges, which do not dull readily and are easily sharpened.

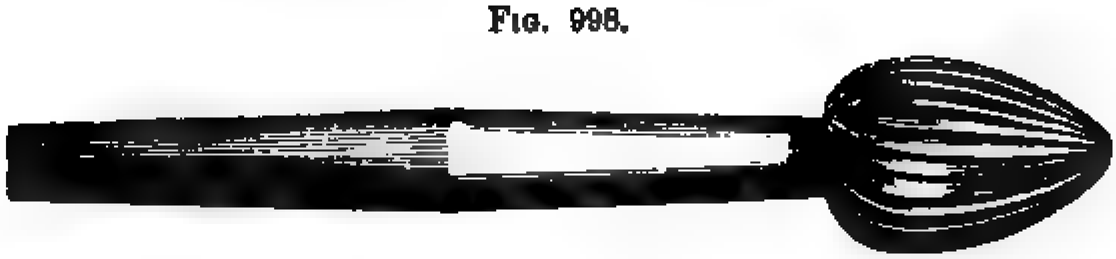
Lathe burrs and file-cut wheels will be found very useful if there is to be much reduction of thickness—Figs. 997 and 998 represent one of each—the burrs in sets of four and the wheels in sets of three. Sufficient thickness must be left in the body of the plate for strength, but the edges should be chamfered off. A pair of calipers (Figs. 949, 950) are required to measure the thickness of the plate if it is to be reduced by files and scrapers, and the use of this instrument will lessen the danger of cutting through the plate. Some operators next use sand paper or emery cloth; others use pumice stone on cork wheels; many prefer Scotch stone. The third step is the use of rotten stone (not Tripoli, which cuts with too keen a grit), either on a brush wheel with tallow or oil, which is the more rapid process, or on a stick of some hard wood, with water, which is the more cleanly. A little oxide of zinc on a soft

FIG. 995.

FIG. 996.

FIG. 997.

FIG. 998.



wheel or on the finger will give a brilliant finishing polish, but is not essential, as the rotten stone can be made to polish very highly. After trying the piece and finding that no part of the edge requires alteration, a bright surface color may be given by placing the piece in alcohol and exposing to the sun's rays for six or twelve hours. Some regard this as an improvement; it certainly does not injure the quality of the plate, but the original mahogany color of the vulcanite is in much better taste than the bright vermilion tint thus given. In finishing partial cases it will prevent accident if, after filling the edges, plaster, or modeling composition, or gutta-percha is fitted to the palatine surface of the plate; the subsequent operations can be conducted more rapidly and with less danger in delicately shaped pieces. Vulcanite is softened by heat; hence a piece is sometimes bent by revolving the brush-wheel too rapidly. A piece that has been in any way bent or warped may be restored by heating either in boiling salt water or in oil to about 250°. While soft it may be bent with the fingers; but as this guesswork method is hazardous it is much better to bind it down upon a model and heat to the point of softening.

By pouring plaster upon the palatal surfaces of thin partial plates and allowing it to harden the danger of changing the shape when polishing with a revolving wheel is avoided. To give a polished surface to a vulcanite plate and dispense with the usual finishing up and polishing process, the surface of the wax may be covered with tin foil, which is lightly but smoothly burnished to the surface of the wax. To insure a polished surface to the palatal surface of a vulcanite plate also the surface of the model may be varnished with shellac and then covered with tin foil, evenly applied; but a better method is to obtain a block tin or other suitable metal die from the plaster model and vulcanize upon it. When tin foil is applied to the surface of a wax plate all the wax may be removed without injury to the foil by pouring boiling water upon it. By the use of the improved heaters to vulcanize rubber, although a longer time is necessary than with the common vulcanizers, yet the strength and color of rubber so manipulated are improved. To vulcanize red rubber with these heaters the flask may be heated and packed in the oven; and when this process is completed the machine is closed, and the steam valve is then raised to admit the steam to the packing chamber. When the heat has been raised to 320° the case is allowed to remain in the hot box at that temperature for one and a half hours.

To produce a pure jet-black rubber plate, perfectly pure black rubber should be used, and vulcanized by the *dry* process. The

model and investment should be thoroughly dried before packing the black rubber, and no steam be allowed to enter the packing chamber during the operation. The time required for vulcanizing black rubber by the *dry* process is five hours at 320°. To construct a vulcanite set with a celluloid gum, see chapter on Celluloid.

A modification of the vulcanite process was patented in 1868 by Dr. Stuck. Briefly described, it is the vulcanizing of rubber between two polished tin-foil plates, the articulating plate being formed upon a block-tin model made directly from the impression. The plate comes out highly polished, provided the tin foil has been carefully burnished into shape. On the palatine surface this polish is objectionable; hence we should prefer to vulcanize directly upon the block-tin model, the granulated surface of which is better for adhesion. The plate, thus made smaller than the mouth by the shrinkage of the tin, would in most cases fit better; the difficulty is in removing the finished plate from the metal in case of a deep arch or slight undercut, an objection, however, which is now overcome by using shell or sectional tin models. A second peculiarity of Dr. Stuck's plates is their elasticity, compared with pieces as ordinarily prepared and vulcanized in the same oven. This, we suggest, is due to the retention of the sulphur by the foil plates on either side. We think these elastic plates are usually made too thin under the idea that elasticity, like rigidity, compensates for diminished thickness. This method, though open to some objection, is worthy of careful investigation by every worker in vulcanite.

It sometimes happens that the rubber shrinks from the teeth, leaving a space in which particles of food and saliva collect. The cause of such shrinkage has been ascribed to the fact that the rubber in cooling, from a temperature of 320° to that of the atmosphere, contracts more than any metal, and the plaster of the model and investment after boiling in sulphuretted-hydrogen water for sixty minutes is rendered very soft, and has not strength sufficient to hold the vulcanite in form while cooling; but, on the contrary, yielding to pressure, allows the rubber to draw away from the teeth. It is claimed that any method which will prevent the plaster model and investment from becoming soft will overcome this objection.

Repairing and Refitting Plates.—Vulcanite work may be repaired by removing the broken tooth or block, cutting dovetails in the rubber, and then fitting the new teeth, arranging the wax, and vulcanizing as at first. To describe this method of repairing more in detail: if a tooth or block has been broken the fractured parts should be removed and a dovetail or groove formed in the base

covering the space occupied by the tooth to be replaced. The tooth or block is then fitted by grinding and supported by wax, the dovetail being also filled up rather fuller than is necessary to restore the surface in order to allow for finishing. All of the set, except the portion of the lingual surface over the wax, is then imbedded in the lower half of the flask, and the plaster surface varnished and oiled to prevent adhesion when the upper section of the flask is adjusted and filled with the plaster investment. When the plaster has set and the two halves of the flask are separated, all of the wax is removed, the piece heated up, and rubber packed into the cavity around the tooth or block. The sections of the flask are then heated and screwed together and the process of vulcanizing completed. Another method of repairing rubber plates, and by which pressure is avoided, is to first cleanse the piece thoroughly, and to coat the inner surface with a little oil to prevent the plaster which is poured upon this surface in order to form a new model from adhering. When the plate is separated from the model dovetails are cut into the plate, and it is returned to the model and the teeth adjusted by grinding, after which the surface under them is coated with the rubber solder or liquid rubber, as are also such parts of the teeth and pins that are to come in contact with the rubber. The teeth being replaced, warm rubber is packed under them and into the dovetails, and the case is then invested in one mass of plaster, no flasks being used, and vulcanized in the ordinary manner. Where the plate is cracked or broken into two pieces the parts should be carefully adjusted and secured in place by either wax or ligatures and covered with plaster on its inner surface so as to form a model. The plate is removed from the plaster when it has set and a groove cut out the entire length of the crack or fracture, on either side of which dovetails are formed. When the pieces are returned to the model, the case is placed in the lower half of the flask and invested with plaster, all portions of the plate being covered except where the new rubber is to be packed. The rubber solder is then applied to the prepared surface and the rubber packed firmly into the groove and dovetails. The upper half of the flask is then adjusted and the investment completed, when the case is ready for vulcanizing. Instead of cutting dovetails, which are often disfiguring and sometimes impracticable, a liquid preparation may be used known as Rubber Solder. The surface of the old plate should be brushed over with it just before packing. The adhesion is so perfect that the plate will break through old or new rubber sooner than separate. Before cutting out the old rubber the part of the plate under the broken teeth should be filled with plaster

and then removed, so as to preserve the shape of the ridge; in case the process of repair requires that the plate shall be cut entirely through at this point, it is to be replaced before applying the wax. The second heating darkens the old rubber and makes it more brittle; full cases may admit of one, possibly two, such heatings. Partial cases should be repaired by replacing the entire plate with new rubber, although many repair as in full pieces. We decidedly prefer in both full and partial cases the entire replacement of the rubber. In doing this there are various ways of securing the correct relation of the teeth to the new model. To replace a broken partial or full plate, the teeth being uninjured, attach the broken parts firmly by resinous cement on the lingual surface; soap the rubber, or very slightly oil it, and make a new model; then surround it with a plaster rim, as explained on page 970, coming fully to the edges of the teeth. Remove the resinous cement from the lingual side of the plate and take a plaster copy of this surface and of the inside of the teeth, being careful in partial cases to slope the plaster so that it may be readily drawn. The plaster now enveloping the piece is in three or four parts; remove the plaster from the lingual surface; remove the rim in one or in two pieces; then carefully remove the plate from the model. Soften the rubber plate and remove the teeth; replace the plaster rim around the model and set the teeth or blocks in position, pressing a little wax under each to keep it in place. Now set model, rim, and teeth in the half-flask, first soaking in water to prevent too quick setting of the batter. Soap or cover with foil the plaster surface; then saturate and put in place the remaining lingual piece of plaster; set the other half-flask and pour the remaining half-matrix. Separate flask, pick out the pieces of wax; the case is then ready for packing and vulcanizing. By this process the new plate has the exact shape of the old one, and there is no necessity for moulding a new wax plate. If the plate is of such form as to endanger the model in detaching, soften it by cautious use of the blowpipe flame.

If new teeth or block be required, let this be first fitted and wax properly shaped around it; then proceed as above. But if some modification in the shape or thickness of the plate is required, do not fill the lingual surface with plaster; but after making model and rim remove plate, reset teeth, adjust a new wax plate, and then proceed as in a new piece. If the vulcanite rim outside and above the teeth needs modification the plaster rim must be removed and wax placed there also, as in a new piece.

Dr. George B. Snow, in an excellent article on "Repairing Vulcanite Plates," gives the following suggestions:—

"It is not unusual to see vulcanite plates which have been cracked or broken, and repaired by what may be termed the 'hole and plaster' system. Holes are drilled through the plate along the edges of the crack, and a new thickness of rubber superimposed upon a mass which possibly is already too thick for comfort or convenience, the old crack still remaining as a weak point to occasion further breakage. No advantage was taken of any possibility of union between the old and new material, the dentist having been obviously ignorant of the fact that perfect union can be obtained in such cases if the surfaces of contact are freshly cut, absolutely clean, and properly roughened.

"The great point to be remembered in repairing or making any addition to a vulcanite plate is that the new and old material will unite perfectly, and with such firm adhesion that the plate will be practically as good as new if the surfaces of the old plate where union with the new material is desired are freshly filed, *absolutely clean*, properly roughened, and of sufficient area. To insure these results wax should not be melted upon the surfaces of union in waxing up, and removal of the wax from the mould should be accomplished by means of instruments, and not by hot water, unless, possibly, for the removal of very small particles which cannot otherwise be got rid of. Any amount of the old material desired may be cut away and its place supplied by new, and thus any change wished may be effected. In case of breakage or cracking the plate should be cut away so that the old defects will be wholly obliterated and new material supplied.

"As a first instance, suppose a partial lower plate supplying the loss of the bicuspids and molars on both sides of the mouth to be broken through the bar which extends from one side of the mouth to the other behind the incisors. The fracture is generally a clean one, resembling that of glass or porcelain, and the two pieces may be brought into apposition with certainty. The dentist holding the parts together in exactly the right position, the assistant covers the lingual side of the plate at the point of fracture with a few drops of hot shellac from a shellac stick. A little cold water follows, and the two parts of the plate are firmly cemented together. A brace is now extended across from the molars on one side to those on the other by laying a burnt match on the grinding surfaces of the respective teeth and fastening both ends with a few drops of hot wax. By this means sufficient strength is obtained to allow of the plate being safely handled. A piece of paper or sheet-wax is cut to fit and reach across the lingual space at the lower edge of the plate and fastened therein with wax, a coat of shellac varnish is applied

to the paper, the surface lathered with soap-suds and rinsed, and a model run in the same manner as in filling an impression.

"After this has hardened the plate is removed from the model, which is then given a coating of liquid silex. This is always preferably done in repairing plates at the time when the plate is first removed from the model. The bar may be now wholly cut away close to the body of the plate on either side by a jeweler's saw, the cut being made diagonally so as to make what is termed a "scarf" joint. The surfaces should be further roughened by making a series of shallow parallel cuts across them with the saw, a thick separating file or a thin-wheel engine burr. The parts of the plate are placed upon the model, waxed up and flasked; the model and buccal surfaces of the teeth being covered with plaster, and the parting made so that the plate will be retained upon the model, while the pieces of the bar can be readily removed. After the flask is opened the pieces are removed, the usual gateways cut, and the packing, vulcanizing, and finishing done as usual.

"In the case of an entire lower set broken through the centre, it will be seen that the same directions will apply, excepting as to the amount of rubber to be cut away. A free cut should be made on the lingual side, extending through under the teeth, to and including the labial band; so that the broken surfaces will be entirely obliterated and at least one-eighth inch in width of new rubber supplied between the cut surfaces. An engine-burr will do much of this work nicely, and a wheel-burr is very convenient for the purpose of scoring the surface. The making a model, flasking, and packing will be done as before.

"If one of the incisor-blocks be broken and needs replacement, a new one can be fitted after the model is obtained, and the remaining steps of the process followed as has been described.

"Upper plates are sometimes cracked in the centre, the crack extending from under and between the incisor teeth backward over the palate. This often happens from the amount of rubber just behind the incisors being insufficient. It is not unusual to see it cut away at this point, so that the pins are almost or quite exposed, the plate having its usual thickness at a very short distance behind the teeth. A much larger amount of material will be tolerated here than is usually employed, and often with benefit, not only to the strength of the plate, but to the articulation of the wearer. The curve of the surface of the plate should be made to resemble that of the palate before the removal of the teeth, and it will be found that the extra thickness may extend for half an inch behind the teeth without annoyance to the patient.

"A proper curvature to the surface of the plate just behind the incisors will do much to prevent the disagreeable whistling in making the *s* sound, and will assist in giving the correct enunciation to *sh*, *zh*, and other linguals.

"If the cracked plate fits a flat mouth a model can often be drawn from it as it is; but if the arch is high and the gums projecting it is better, after thoroughly cleaning and drying the plate, to finish the cracking by breaking the plate entirely in two. The two halves may now be fastened together by dropping shellac upon the lingual side, and a model secured from which either half of the plate can be easily removed. The whole palatal portion of the plate can then be removed by a saw-cut, leaving only a narrow margin on the lingual surface inside the teeth. The remainder of the surfaces of fracture are cut away as directed in case of the lower plate, the new surfaces roughened, the pieces of the old plate replaced upon the model (which has received its coating of liquid silex), waxed up, flasked, packed, and vulcanized, the teeth being retained upon the model as before described. The plate, when finished, will show the old rim and a margin of the old rubber inside the teeth.

"It is sometimes desirable to change the substance of the plate entirely, as in case of supposed mercurial poisoning by red rubber; or at least to put what red rubber there may be about the plate entirely out of sight and to reduce its quantity to a minimum. If this is to be done to the plate last under consideration, it should be prepared for flasking as described, excepting that the labial band should be cut away, and everything arranged so that the plate can be separated from the model when flasked. The parts cut away should, of course, be replaced by wax. The case is now set in the flask so as to leave the parting at the upper edges of the gums. The plaster is varnished and oiled and more plaster built on against the labial sides of the teeth, extending from their cutting-edges to the edge of the flask, and again varnished and oiled, so that the appearance will now be precisely similar to a plate flasked so as to be retained upon the model. The ring of the flask is now put in place and filled, and the plaster allowed to harden.

"When the flask is separated the teeth will be found in its ring-section. A few blows of the hammer will dislodge them, with the piece of plaster built against their labial surfaces. This is carefully broken away in two pieces if possible, which are preserved, and the teeth and rubber encasing them is left. The rubber is now filed away as much as is practicable, leaving none of the old rubber in sight and removing enough from the palatal surface to make a new

fit to the model. The teeth and plaster are replaced in the flask and the case is ready for packing and vulcanizing, and when finished none of the old rubber will be seen, and the plate will be practically as good as though the teeth had been removed from the old plate and reset.

"It is sometimes difficult to prevent the rubber from showing at the joint between the incisors; great care should be exercised in bringing the sections together properly and in holding them in position while flasking. If there is room a small wisp of loose cotton, not larger than a thread, may be tucked into the joint on its palatal side, the edges of the blocks being beveled to admit of this being done.

"It is evident that the change from red to black rubber just described can be made with a whole plate or a broken one indifferently. If a change of articulation and a new fit to the mouth is also desired on account of shrinkage of the gums, the plate should be prepared so as to draw from the model, and a few small pieces of wax put in the palatal side to bear upon the alveolar ridge, and give the right articulation by trial in the mouth, the centre of the plate being cut away to facilitate the fitting of the plate to the model. A fresh model of the mouth being secured from an impression, the plate is waxed on to it, the case is flasked with a false piece of plaster built against the labial sides of the teeth as has been before described, and the plate afterward removed and cut away as much as desired, a considerable amount always being taken from its palatal surface.

"This process does all and more than is specified in the Hyatt patent, as it not only gives a new fit, but allows the material of the plate to be substantially changed. Holes and dovetails, it will be seen, are wholly unnecessary, and the fine serrated edge left by cross-cutting the surfaces of union will be found an excellent guide in scraping the plate to avoid overlaps. The use of shellac as a cement is strongly advised in repairing, as it is rigid and brittle when cold, and the broken parts, if once properly brought together, cannot get out of adjustment without at once attracting attention by the breakage of the cement. Wax does not answer the purpose nearly so well.

"The amount of shrinkage in vulcanite from cooling after vulcanization is not so generally noticed and provided for as it should be. Plates composed of single teeth do not give trouble from this cause, but full plates on which sections are mounted are often very vexatious to the dentist from the change of shape they undergo from shrinkage.

"The reason of this is that the ends of the sections abutting form an arch of porcelain, which expands or contracts but slightly from changes of temperature. The rib of vulcanite immediately inside this arch, and in which the pins are imbedded, forms a second arch closely attached by the pins to the first one. The plate is moulded to the model and hardened at a temperature of about 320°, and is afterward placed in the mouth, where the temperature is in the neighborhood of 90°. Under these circumstances the contraction of the rubber which ensues has the effect of lessening the radius of the arch, drawing the heels of the plate together, thus rendering it a little too narrow to fit the mouth accurately. This has the further effect of elevating the palatal portion of the plate, which, when tried in the mouth, will usually be found to rock slightly, often so much as to interfere with its fitting.

"If the plate has been made upon a model taken from the mouth the difficulty is overcome by warming the back part of its palatal portion, pressing it down slightly, and cooling it while the pressure is continued, the narrowing of the plate being too small in amount to be itself objectionable.

"This change can be accomplished with more certainty by making a small plaster cast of the palatal portion of the plate, placing upon the part where the change is desired a small piece of folded paper, folded so as to present a thick centre, and forcing the plate down upon it after its palatal portion has been warmed.

"The shrinkage here alluded to becomes a more serious matter when the plate is re-vulcanized in the course of repairing it. It is flasked when the change in form by its shrinkage has already once manifested itself, and again heated to 320°; and in cooling a second shrinkage takes place, it becomes still narrower, and its fit, already defective, is made perceptibly worse. It now often becomes a matter of necessity to bring it back to its proper shape before it can be worn with comfort. To provide for this a small dot should be made with a pointed instrument on each side of the plate immediately behind the molars, and a pair of dividers set to the distance between these points. After vulcanization the dividers can be applied to the marks, and they will indicate the amount of shrinkage the plate has experienced. Let the plate now be warmed just behind the incisors and in the mesial line by repeated short puffs of a blowpipe flame. This must be done carefully and the heat not allowed to extend over an area much exceeding half an inch in diameter. When the rubber is sufficiently softened the plate should be taken by the heels, a pull made upon it sufficiently forcible to expand the

arch, and a stream of cold water applied. The dividers will at once show if the change made is sufficient.

"When the plate is now tried in the mouth it may be that the back edge will not touch the roof, and air will be admitted under the plate, in which case the back edge should be warmed and forced up to its proper position.

"The same remarks apply to full lower plates as well, which often are found to have lost their fit in a measure, after having been re-vulcanized. The process above detailed will suffice to restore them to their former fit and render them again comfortable to the wearer."

If the teeth are to be reset because of change from absorption, or because of some inaccuracy in the fit of the plate, it will perhaps be best, in most cases, to proceed just as for a new piece, grinding the joints again for any change of arrangement. Sometimes re-jointing the blocks may be saved by bedding their cutting edges and cusps in a gutta-percha rim before detaching from the plate; this will permit their adjustment to the new wax plate in a continuous arch. Sometimes the old plate may with advantage be used as an impression cup by roughening the rubber and using a very thin layer of wax or plaster, whichever best suits the case. In making the model extend it backward, as before described under Articulation of Plastic Work. Before removing the piece complete the articulator, making the plaster cover the edges and crowns of the teeth one-eighth of an inch. By setting the blocks, when removed from the old plate, into their depressions on the articulator the exact relations of blocks to the model is preserved; also, if the plaster of the impression is made accidentally too thick the articulator may be slightly closed. The wax plate is arranged first on the outside; the half-articulator is then removed and the inner part of the plate shaped. The articulating portion is then cut off, the model set in the flask, and the process completed in the usual manner.

Gold, platina, or aluminium plates may also be re-fitted to suit a mouth changed by absorption. Perforate the plate with holes about size No. 22 (Fig. 798), countersunk on lingual side, regularly arranged and about half an inch apart. Fill the lingual surface between teeth with plaster; remove this when hard and make countersinks in it opposite each hole in the plate. Set the plate on model and fasten it with wax around the entire edge; then place in half flask as usual. Replace the countersunk pieces of plaster and pour second half matrix; this piece of plaster and the wax around the edge prevent the batter of the matrix from getting between plate and model. Separate flask, cut vents, put in a sheet of prepared

rubber of proper size, press matrix together, and vulcanize. The impression may be taken in the usual cusps or in the plate itself, and with either plaster or wax, as the case may require; if taken in the plate, cleanse this carefully after making the model. The adhesion of the rubber may be increased by cutting the palatine surface of the metallic plate with a sharp graver; it should be carefully cleansed just before packing the rubber.

Dr. Richardson gives the following method of refitting gold or vulcanite plates with a new vulcanite lining: "Perforate the palatal portion of the plate with from eight to twelve holes at different points, and also the extreme borders, from heel to heel of the plate, at intervals of one-eighth to half an inch apart and near the edges. These holes may be enlarged to the dimensions of a medium-sized knitting-needle; or, if the piece is of vulcanite, to twice or three times that size. On the lingual and buccal surfaces the holes are well countersunk with a burr drill. The plate is employed as a cup or holder to take an impression of the mouth in plaster, being pressed up closely to the parts. The plaster forced through the holes, and filling the countersinks on the opposite side of the plate, will serve to bind the plaster to the plate and prevent the two from separating as they are detached from the mouth. When removed the plaster impression lining the plate is trimmed even with the borders of the latter and varnished and oiled. The lower section of the vulcanizing flask is now filled with a batter of plaster on a level with its upper surface, and the impression filled with the same is turned over and placed in the centre of the flask, with the edges of the plate touching the surface of the plaster. The plate and adhering plaster are now carefully separated from the model. After cutting out the plaster from the holes and countersinks in the plate the plaster forming the impression is detached from the plate and the holes and countersinks filled with wax. The plate is then readjusted over the model and (the surrounding surface of the plaster in the flask having been varnished and oiled) plaster is poured in upon the upper surface of the plate and teeth, filling the upper ring. When the plaster is sufficiently hard the two sections of the flask are separated and grooves formed, running out from the matrix to the margins of the flask. A sufficient quantity of vulcanizable rubber is now either placed upon the model or packed in upon the palatal surface of the plate; before doing which, however, the wax filling the holes and countersinks in the plate (and which was placed there to prevent portions of plaster last poured, in forming the matrix, from filling them up) should be worked out with a small instrument. The whole being sufficiently heated the two sections of the

flask are forced together, expelling redundant material. The piece is then vulcanized."

The late Dr. Wildman suggested the following method of forming a new plate without changing the articulation of the teeth: "Roughen the palatal surface of the rubber plate to cause the plaster to adhere to it; then use it as an impression cup to take a plaster impression, being careful, when it is in the mouth, to preserve the articulation. In this impression cast the model; trim and cut conical holes at several points in its outer face. Now, before separating the impression from the model, make a cast of the face of the teeth in two or three perpendicular sections, extending to the base of the model, using a solution of soap or other parting substance on the plaster model. Remove this mould of the face of the teeth, which indicates their true position relative to the model. Then take the impression from the model. By the aid of heat sufficient to soften the rubber remove the teeth from it. Next make a model plate with prepared gutta-percha, 'wax and paraffine (or modeling composition).' Now secure the sections of the mould of the face of the teeth to the model (their place will be indicated by the conical holes or keys); adjust the teeth in their proper positions in the plaster mould of them, and build up with wax to the proper form of the model set. This being done test its accuracy of contour and articulation by placing it in the mouth. Then, using the model, proceed as for making a new set." The method just described requires the presence of the patient; but cases occur where this is not possible, and owing to accident a new plate is necessary and the articulation must be preserved. Take a case, for an example, where the plate is so fractured that it cannot be repaired, and yet is capable of being temporarily adjusted by means of hot wax dropped from a spatula. When this is done the palatal surface of the plate is coated lightly with oil and plaster batter poured into it to form a model. Then trim the edges of the plate and sides of the model, and form holes of a conical shape to act as keys for the mould which is made in sections of the outer face of the teeth. When this mould has become hard the sections of it are removed, as well as the plate from the plaster model. Undercuts may prevent the ready removal of the old vulcanite plate, and in such a case, to prevent injury to the model, the old plate should be softened by heat. The subsequent manipulation is the same as in the previous method. When the plate is broken in half a rubber plate may be repaired by a method suggested by Dr. Gilbert: "Remove the denture, and with a fine Swiss saw cut away the palatal portion of the plate to within about an eighth of an inch of the inner surface of the teeth. In this re-

maining portion cut dovetails to retain the new rubber, and also form an undercut channel in the portion which fits over the alveolar ridge in the line of the break, as far as the edge of the rim; secure the parts to the model with wax. The cut-out palatal portion may then be laid back in place to aid in waxing up that part. Invest in the flask, covering the labial and grinding portions of the teeth, as in other repair work. After separating remove the part desired to be replaced with new material; pack and vulcanize as usual."

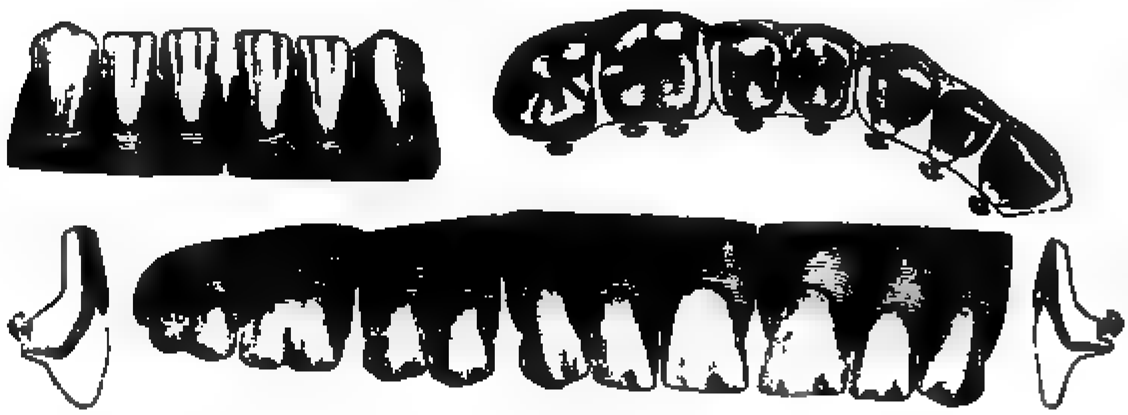
Partial pieces can usually be retained by stays and the fit of the plate. If clasps are called for these may be made of rubber alone if the clasps are short and the rubber elastic; or of rubber strengthened by a gold wire, which is to be curved around the clasp tooth just before packing. A gold clasp may also be fitted and retained in the rubber either by a projecting slip of the same metal or by soldering into it one or two platinum pins. Fig. 999, taken from Prof. Wildman's monograph, represents these two forms of clasp; but in cases requiring clasps we very decidedly prefer a gold plate. The larger size of vulcanite plates necessary for strength will usually secure adhesion with the help of stays or half clasps; in none of these cases do we consider the vacuum cavity of any service.

FIG. 999

Combination of Vulcanite and Metallic Plates.—Blocks or gum teeth may be secured to gold plate by vulcanite instead of by soldering. Blocks having a porcelain gum on the inside, finished to the plate and having a hole in the base opposite each tooth, present a very handsome appearance when attached to gold plate by vulcanite, and may be made very secure. The hole should be of good size (from Nos. 12 to 15, Fig. 798), but must not come so near the translucent front of the tooth as to permit the color of the rubber to darken it. In this and the subsequent modes of attachment the swaging, articulation, and grinding of blocks is done as usual, except that there is less necessity for close fitting to the plate than in case of soldered work. The temporary plaster rim, elsewhere described, must in all cases be used, so as to permit removal and correct replacement of teeth. In case of the blocks just described, press each block into place over a thin layer of wax on the gold plate. The wax projection made by each hole shows where to drill the plate for the pins; then remove plate, drill holes, and solder roughened or headed pins into the plate opposite each hole; fasten the blocks temporarily with wax, then invest in the vulcanizing flask, so that on separating the matrix the plate shall come away in one half, the teeth in the

other. Fill the holes with rubber and place a strip over the base of the blocks; warm and replace the two halves of the matrix, and vulcanize. Vulcanite blocks, such as those in Figs. 1000 and 1001, may be very firmly attached to metal plates by some one of the

Fig. 1000. Fig. 1001.



methods represented in Fig. 1002. Set the teeth or blocks in the temporary plaster rim and distinctly mark a line around the ridge, just under the head of the pins (C); mark across this line the position of each pin (*a*, *b*, *c*, *d*); then remove blocks and prepare the plate for the different plans of retaining the vulcanite. 1st. For an aluminium plate which can have no soldered pins drill a row of small

Fig. 1002.

holes on the line between the pins; set it in the counter-die, and with a tapering punch enlarge each hole, with the projecting burr next the tooth (C, *c*). Let each hole be not smaller than No. 20 (Fig. 798). In some cases a smaller set of holes may be punched or drilled in the outer edge above the gum (C). Swage the plate again to correct the effect of this punching; then place it on model, replace blocks, arrange wax, and prepare for vulcanizing. 2d. Arrange the plate firmly on a piece of charcoal, set small cups of gold or platina on the line, between the pins (A, *a*), with a small piece of solder at each, and solder them all at one heating. 3d. Or drill small holes on the line, between the pins of the teeth (B, *b*), and insert headed platina or gold pins, and solder them. 4th. Or drill

two holes between the tooth-pins (E, *e*) and insert a loop; only one hole is really necessary, as the other end of the loop may be shortened so as just to touch the plate, to which the solder will attach it. 5th. Lastly, a wire may be bent in a series of waves (*d*), so as to pass under each tooth-pin (or just behind it if the pin is too close to the plate, but never over it) and rise from the plate between the pins. Adjust this wire accurately, with the blocks in place; mark the points of contact; then remove plate and solder the wire. The last four methods are applicable to gold and platinum, which admit of soldering. In soldering no plaster investment must be used, and the plate must have a good support on the charcoal; with these precautions careful soldering will not warp or spring the plate. If sprung the pins and loops make it necessary to cut a deep groove in the lead counter-die before attempting to swage.

After completing either of the five plans here described re-adjust the teeth in the plaster rim and fasten them in place with wax, trimmed to the shape required for the vulcanite; then invest in the flask and vulcanize as before described. By avoiding excess of rubber, using only so much as is necessary to conceal the pins or loops, the vulcanite band may have a very neat appearance. Some dentists partly conceal the rubber by an inside and outside band; but if concealment is necessary, we should prefer to do it by the form of blocks above given. If the inside band is used the simplest method is to mark the line of its position; then, by skillful use of the hammer, a strip of gold can be *paned* and with the pliers *bent* so as to have a uniform slope and a close fit; a file will be necessary over small prominences; this method of paning is simpler than either swaging a band or first making a lead or tin pattern. If cast plates of aluminium or other metal alloys are used it is only necessary to drill holes, as many, and of such size, as may be thought necessary, in that part of the plate next the blocks; they may pass through to the palatine surface if necessary, and be countersunk. It is very important to ascertain, by trial, that the closely fitting edge of aluminium does not interfere with the teeth in separating and replacing the flask.

A method of attaching porcelain teeth to a metal base with vulcanite was devised by Dr. P. G. C. Hunt, and a process very similar was afterward introduced by Dr. Engle. It is described by Dr. Hunt as follows: "Thus far we proceed as we do for ordinary gold plate work. We will now suppose the teeth ground and jointed, leaving as much space between the teeth and plate as the plate will admit of. We next mark with a sharp-pointed instrument on the labial surface of the plate each point where it is necessary to place

a loop for purposes hereinafter described; then apply wax to the external or labial parts of the teeth and plate, in any manner sufficient to retain the teeth in position; remove the wax from the lingual parts of the teeth and plate, and mark the position on the metal where it is desirable to insert the loops; remove the teeth and wax, and with a small bow-drill make holes through the plate at the several points previously determined on for the attachments about the size of an ordinary plate-punch hole; take a wire or ordinary gold plate cut in strips, say from a half to one line in width, being

FIG. 1003.

governed by the amount of room there is under the base of the teeth, and with small round-nosed pliers bend the strip around; grasp both ends with square-nosed pliers; draw the round-nosed pliers from the loop, still grasping the square-nosed pliers with the left hand, and with a hammer strike the top of the loop a sufficient blow to keep the ends from springing apart; cut off the ends and dress down to fit the holes in the plate; after which solder on charcoal or other suitable substance without investment. Fig. 1003 illustrates the bent or hooked wire soldered to the base. Pickle, dress, and polish that portion of the plate to be exposed to view. Bend and flatten the pins; arrange the teeth, waxing so as to cover up the loops if practicable. The loops should be placed as near the base of the teeth as possible, the rubber forming, when finished, a part of the general concave shape which is desirable in upper dentures and which it is not possible to obtain with ordinary soldered work. Then with silicate of soda paint the joints, to keep the rubber from forcing in where it would show after vulcanizing. Flask, vulcanize, and finish as usual.

Celluloid can be attached to a metal plate with the same loops and

hooks by sawing out the palatal portion of the celluloid blank, and trimming away as much of the remaining portion which covers the alveolar ridge as is necessary to avoid having an excess of material. When investing the piece the line of separation is made at the edge of the wax rim, thus permitting the plaster to cover the palatal portion of the metal. When the sections of the flask are separated the metal plate will occupy the lower and the teeth the upper portions.

The attachment of vulcanite to metal plates is an extremely useful and important application. It loses one of the peculiar advantages claimed for vulcanite, the accurate fit of the plate; but it makes very strong work, and is more cleanly than ordinary swaged work, because all interstices are completely closed. It also gives a shape behind the teeth more conformable to the natural shape of the teeth and gum. It obviates two of the principal objections urged against vulcanite—thickness of the plate and contact of the rubber against the gum and tongue. It dispenses with that accurate grinding of the base of blocks required in ordinary gold work, and obviates the risks of the soldering process. It is applicable to full sets, or to partial sets where the teeth are in groups of three or more. It is best repaired by removing the entire vulcanite attachment; but those who patch up old rubber plates can, with greater impunity, patch the "combination work;" since the strength of the piece depends mainly on the plate, the brittleness of second heating is of less moment. Another argument in its favor is that it makes available to gold-dentists the beautiful forms of rubber blocks, without identifying them with that class of rubber-dentists who, by accommodating the style of their work to the cheapness of the material, have brought much discredit upon dental mechanism. Dr. R. M. Chase has invented what he styles "a metallic-roof plate," which comprises a plate of gold or other metal to cover the roof of the mouth and a vulcanized extension attached to the edges of such a plate and extending over the alveolar ridge. The edge of the metallic plate is serrated or notched, and bent upward at an angle so that the vulcanite portion can be attached. In such a denture the metal portion only comes in contact with the roof of the mouth, while the vulcanite is restricted to the under and outer surfaces of the alveolar ridge. The method of constructing such a denture is described by Dr. Chase as follows: "Shape the plaster model so that it will easily drop from the sand by its own shape and weight by simply raising the flask at a right angle from the table. After shaping the model as described, mould wax and paraffine base-plate to the labial and buccal portion of the alveolar ridge of the model, filling all undercuts and irregularities, letting it extend over on to

the alveolar ridge to the depth of from one-eighth to one-quarter of an inch. This should be beveled toward the palatine aspect, this being done with a view to where the turned-up edge of the plate will not interfere with the pins of the teeth. The whole model, including the wax, should be shaped on a true bevel from the base to the beveled edge. Varnish the model, including the paraffine wax, with two or three coats of white shellac dissolved in alcohol. A model when prepared in this manner presents a beveled surface at all points, which makes sand-moulding simplicity itself. When the shellac varnish is dry mould in fine sand. Do not pack the sand over the face of the model but a trifle, rather depend upon the weight of the sand to do this. Pack thoroughly around the side and top of the flask, so that when it is leveled off and reversed none will drop out.

"Having secured the impression of the model, melt zinc and make a die. When the die is cool reverse it and pack sand around it nearly as high as the top of the ridge, so that only the palatine surface and the beveled edge is exposed. Place over this a rim of iron about one inch larger in diameter than the die, and pour melted lead into the rim to the depth of one inch. Remove this counter-die and make another, but do not let the sand extend up higher than to one-half an inch of the top of the ridge. The first counter serves to shape and partially swage upon. When this is done trim the edge of the plate where it bends over the edge of the die to the proper shape, not letting it extend beyond the top of the beveled edge. The second counter serves for the final swaging. It is seldom necessary to make more than one die and two counter-dies as described. When the plate is shaped upon the first counter, notch the turned-up edge about one-eighth of an inch apart, cutting into the metal to about one-thirty-second of an inch—where the turned-up edge commences or where it is to leave the cast, place back upon the die and smooth down the notched points which will curl up in cutting. Anneal and place upon counter No. 2 and strike the die with two or three dead pushing blows; this will finish the swaging process. Now saw or trim off the base of the model, remove the wax and paraffine, and adjust the trial-plate. Secure the bite or articulation; after this is done remove the trial-plate and fasten the metallic plate to the cast in position by a few drops of wax. Soften base plate, place this upon the labial and buccal surface of the cast, connecting it with the edge of the plate. Proceed to wax up the teeth in usual manner, letting the wax-backing extend on to the plate as far as desired when finished. When adjustment of the teeth and waxing process are completed, flask the same

as for rubber, except the plaster should cover the metallic plate, extending a little above the edge or border of the wax. Soap the plaster, adjust the upper half of the flask and fill with plaster. When hard, warm the flask and open. Remove all wax by pouring boiling hot water upon it. Now, with a pair of narrow beak forceps, bend the notched parts every other one in opposite directions. This gives additional security against becoming detached when the extension is moulded to it; vulcanize and finish." A vulcanized plate may be bleached by placing it in a glass vessel containing alcohol, and exposing to the sun's rays for from four to six hours; covering the top of the vessel with a plate of glass will prevent rapid evaporation. The pink rubber employed to give a more natural color to the gum requires to be bleached in order to render it sightly. To remove teeth from a vulcanite plate the piece may either be passed through an alcohol flame until the teeth become hot, or the set may be boiled in oil or imbedded in hot sand of such a temperature as will not char the plate. The latter method is preferable when care is taken to have the sand at a proper temperature, as the teeth or sectional blocks can be readily detached and all rubber adhering to the pins be removed by means of a pointed excavator. Any slight imperfections in a vulcanite plate in the form of a small hole left by plaster particles can be repaired by melting gum shellac and incorporating it with vulcanite filings. A cement thus formed can be introduced in a plastic state and made smooth with a heated spatula or burnisher.

Rubber can be made liquid for use as a rubber solder by cutting it into small pieces and dissolving by either benzine, turpentine, chloroform, ether, or bisulphide of carbon, all of these agents being solvents of rubber. The shape of a vulcanite plate can be changed by obtaining a correct impression and model of the mouth, upon which the plate, having been previously heated, is pressed by means of a napkin or piece of chamois skin, and held in position until it is cold. To soften the rubber plate the set may be immersed in boiling water, or placed in an oven with the teeth downward until the rubber becomes pliable; in the latter method care should be taken that the rubber is not blistered or charred. A more certain method, however, is to reconstruct the set.

For quick repair in the case of a broken tooth or sectional block a hard, quick-setting amalgam is sometimes employed, first cutting out a suitable cavity about the space to be filled, and after the tooth is properly adjusted packing the amalgam under it and about the pins, the tooth being firmly held in place during the operation. Wood's fusible metal has also been used for the same purpose, and

to close holes, the latter being countersunk on both surfaces and made oblong.

Spring plates consist of elastic partial pieces which are so constructed and vulcanized as to press against certain natural teeth, and thus be retained in position. After securing the model a little of the palatal surfaces of the plaster bicuspids and molars is scraped away, and in forming the trial plate the wax is allowed to extend some distance from the necks of the retaining teeth upon the model, toward the grinding surfaces, in the form of partial stays. These plates are so shaped as to leave the central portion of the mouth free, no air-chambers or clasps being necessary. As the tendency of spring plates is to press the retaining teeth outward they are not generally used. For mouths having soft places Dr. Land recommends an air-chamber covering four-fifths of the palatine arch and including certain parts of the alveolar walls (Fig. 939); and the same writer remarks: "To insure a comfortable adaptation the pressure must be so equalized that, as the alveolar ridge recedes, undue stress will not be brought on the palate. For this reason an air space, covering almost the entire surface of the palatine arch, is desirable, as thus the pressure is better distributed and brought to bear directly on the alveolar ridge, where there will be the least danger of injuring the mouth, thus avoiding the riding or rocking of the plate on the hard palate. The conventional air chamber, with its acute angles invariably placed on the most rigid portion of the hard palate, soon outlines itself in the tissues, demonstrating a failure to properly utilize atmospheric pressure and injuring the mouth by inducing absorption unnecessarily."

Dr. Hurd has suggested what he terms a "flange section" for lower plates, which is described as follows: An impression is first taken in wax, and this is used to obtain a plaster impression. The extreme projecting plaster at the sides of the tongue is cut off, and the surface varnished and filled up, so as to make a full model across from heel to heel, running far back upon the process, to keep the lip from pressing the plate back when the force of the muscles and lip is brought to bear upon it. After obtaining a correct articulation, a gutta-percha plate being used for the purpose, the teeth are set directly upon the centre of the margin, perpendicular in front, but inclined at the sides, so as to allow for a sufficient space to form an outer flange for the lip to press down upon. This flange is then made by means of wax about one-third of an inch thick, with the inner surface rounded up in the same manner as the outside, but not made so thick and high, for the tongue to rest upon and keep down, thus excluding the air, the saliva which collects

under the tongue also aiding in making the vacuum. It is necessary that the flange should rest gently against the cheek to give steadiness to the plate, and the teeth must be so arranged that they are level on the face. After vulcanizing, the piece is first cut away by filing at the hard margin on the under side of the outside flange, and increasing it near the edge of the plate at the cheek, and making a chamber. The inside of the plate is also cut away to free it from the sublingual muscles and glands, which tend to elevate the plate when the tongue moves upward. In cases of malformation a thin, flexible rubber flange may be attached to the plate instead of the hard flange, so as to hold securely and conform to the movements of the muscles.

Lining Vulcanite Plates with Gold.—Vulcanite plates are sometimes covered with a gold lining on the palatine surface to prevent the contact of the rubber with the mucous membrane. What is known as the "vulcan gold lining" is composed of chemically pure gold, with a thin covering of pure silver. The flask is packed as usual and the gold is applied in one piece to the surface to be covered. The union between the rubber plate and the gold covering is mechanical; and the sulphur in the rubber when set free by the action of vulcanizing attacks the silver, sulphurizing the surface, and to this the rubber tightly adheres.

If the rubber plate is covered by the gold on both sides it is claimed that the vulcanite becomes tougher when vulcanized, for the reason that during this process the pressure against the metal gives the plate a surface more dense than it will have if vulcanized in contact with plaster. The sheets of this form of gold are of the thickness of No. 20 foil.

Vulcanite for Irregularity Appliances.—Of the peculiar adaptation of the vulcanite material to the correction of irregularity mention has been made in the chapter on that subject. No further special directions are required except on two points: first, to have the plaster which makes the model perfectly smooth and free from air bubbles; secondly, to coat the teeth before vulcanizing with soluble glass or collodion solution. Attention to these two points will give a plate which, if the impression is correct, will fit the teeth with most perfect accuracy.

Directions to Patient.—Upon the completion and insertion of a vulcanite piece the patient should be cautioned to cleanse it thoroughly at least once a day; also to keep it in water when not worn in the mouth. Extreme cleanliness is advisable in all kinds of artificial work, and many patients need no such direction; the special necessity for care in the case of vulcanite arises from the

tenacity with which the mucous secretions adhere to the surface if from neglect they are allowed to collect upon it. This coating is most apt to collect at those points where the friction of the tongue and of the food does not remove it; the same care is necessary for its daily removal as is required to keep the natural teeth in good order. There is, however, this difference between cleanliness of the teeth and of the plate, that while both are essential to purity of the mouth, the secretions have no chemical action upon the plate, as they have upon the teeth.

One point affecting the durability of vulcanite plates has, perhaps, not been determined by a sufficient experience. It is well known that silver and eighteen-carat gold undergo a change in the mouth which causes them to become more or less brittle; such is not the case with twenty-carat gold and with platinum. The change in these cases is partly the effect of mastication, acting as do the repeated blows of swaging; partly a galvanic action between the molecules of the alloyed metal. A similar but much more rapid change takes place in the gutta-percha which is used for impressions; also in the vulcanized gutta-percha and in all those preparations of vulcanized rubber with which foreign substances are largely mixed for the purpose of modifying the brown or red color. The brown rubber, being purer, will probably retain its toughness and elasticity longer than the red rubber. We have some specimen pieces of red rubber which seem, at the end of twelve years, to possess their original strength; and we know of one partial piece that has been worn constantly for ten years, which has never been repaired, and seems as strong as when first made. This point, however, requires the collected experience of many observers during a period of many years, carefully distinguishing between the brittleness of over-baking or twice vulcanizing, and that which may supervene as the result of certain molecular changes in the substance of the material. It is a change which, unlike the galvanic action in gold and silver plate, may not require the presence of the buccal fluids, but which will probably take place alike out of the mouth as in; for such is shown to be the case with gutta-percha.

"Against the use of the vulcanite it is urged: 1. That it has degraded the art by the extent to which it has introduced cheap work, and by the ease with which its peculiar manipulations are performed. 2. That its medicinal action upon the system is such as to render it an unfit material to be put into the mouth. 3. That it produces an unpleasant burning or heating sensation in the mucous membrane, and a permanent sponginess of the gums, not attendant on the wearing of metallic plates. 4. That the mucous secretions require more care

for their removal from the surface of the plate than most patients are in the habit of giving; hence the liability of the piece to become unpleasant. 5. That to give the necessary strength requires a thickness of plate that is clumsy and interferes with distinctness of enunciation. 6. That the work becomes brittle in the course of a few years. 7. That it is troublesome to repair in such a way as to maintain its original strength.

"In favor of the use of vulcanite it is urged: 1. That the absolutely perfect and unfailing accuracy of its adaptation to the model places it, in this important respect, before every other material in use for dental plates. 2. That, being perfectly impervious to fluids and insoluble, it is a pure and harmless material. 3. That, being devoid of all galvanic action, it is more agreeable to patients than soldered and alloyed plates. 4. That it has none of the wearing action of metal upon teeth against which it becomes necessary, in partial cases, to bring it in contact. 5. That the great lightness of the material makes it very pleasant to the patient, and permits the filling out of deficiencies in the ridge with the least possible addition to the weight of the piece. 6. That this lightness, together with its peculiar elasticity, lessens greatly the danger of accidental breakage of either teeth or plate; thus making it, when properly constructed, the strongest of all dental substitutes. 7. That the plastic properties of the vulcanite and the readiness with which it may be moulded and hardened against any surface, however irregular, give it a wider range of applicability than any other substance used in dentistry."

CELLULOID.

Celluloid, like vulcanized rubber, a cheap base for artificial dentures, was first introduced in 1869, and during the existence of the "rubber patents" was much used by those who objected to become licensees of the Goodyear Rubber Company. The comparatively recent improvements made in the material, and methods of manipulating it, have commended celluloid to professional favor as a plastic substance more in harmony with the soft tissues of the mouth, as regards natural gum color, than rubber, although it is more liable than the latter substance to change form after moulding and to absorb the oral secretions if not properly manipulated. Celluloid is obtained from cellulose, the woody fibre which constitutes the framework of plants, examples of which are furnished by hemp, linen, cotton-wool, etc. In the manufacture of celluloid the cellulose of hemp, which is the strongest, is first converted into paper by the usual method, its chemical properties during this process remaining

unchanged. The hemp paper is then converted into pyroxylin (gun cotton), by immersing the paper in a strong mixture of nitric and sulphuric acids, afterward being thoroughly washed.

This process increases its weight about seventy per cent. and renders it highly explosive, taking fire at 300° Fahrenheit.

The pyroxylin is then reduced to a pulp, and a mixture made of the following ingredients: Pyroxylin, 100 parts; camphor, 40 parts; oxide of zinc, 2 parts; vermilion, 0.6 part. It will be seen, therefore, that celluloid is composed principally of pyroxylin, with camphor (dissolved in alcohol) as a solvent, and that it contains less vermilion than the red vulcanizable rubbers. After the ingredients are thoroughly mixed immense pressure is brought to bear upon the mass by means of a hydraulic press of two thousand pounds to the square inch, which squeezes the celluloid through a small orifice in the side, near the bottom, of a strong cylinder. This pressure is necessary to condense and solidify the celluloid, which, as it presses out of the orifice in the cylinder, is cut into pieces and moulded by heat and pressure into forms suitable for dental use, called "blanks," and which in size and shape approximate to the bases of upper and lower dentures. These "blanks" are then seasoned for some two months in a room kept at a temperature of 160° Fahrenheit, when they are ready for use. To manipulate a celluloid blank into a proper denture is by no means as easy an operation as the working of vulcanizable rubber, celluloid being a material that is liable to alteration in shape and character under different circumstances. Repeated failures are the result of manipulating celluloid like vulcanizable rubber; hence perfect moulds, equal pressure, and metal dies are absolutely necessary for the usefulness and durability of such a denture. Experience proves that metal dies, which produce a surface proof against disintegration, are alone reliable. The coating of the surface of a wax and paraffine plate, and also of the plaster model, with tin foil, overcome somewhat the difficulty of preventing the loss of too much of the camphor solvent by absorption, and obviates the necessity of removing the original surface possessed by a celluloid plate when it is taken from the heater.

In the preparation of a celluloid denture the manipulations are the same as for vulcanized rubber until the case is ready to invest in the flask. The plaster used for working celluloid should be of the best quality, and not mixed too thin. The pink paraffine and wax answers better than any other material for a base plate, a thin paraffine-and-wax sheet being used for the plate, which is strengthened by adding to its surface either warmed paraffine or modeling composition, first covering the paraffine plate with No. 60 tin foil in order that the

modeling composition may be removed without injuring the smooth surface of the thin paraffine base plate. The teeth are arranged upon the base plate and secured by dropping melted paraffine and wax

FIG. 1005.

FIG. 1004.

FIG. 1006.

around their roots. A stick-form of paraffine and wax can be obtained, which is very convenient, the method of using it being represented in Fig. 1004.

The paraffine and wax compound is then carved into the shape of the gum desired by carving instruments, such as the set of Dr. W. W. Evans, represented in Fig. 967; or a simple scraper may be used, such as is represented in Fig. 1005. The surface of the paraffine and wax may be made very smooth by directing upon it the flame of an alcohol lamp with a blowpipe, care being taken to preserve the outlines of the carved gum. The more perfectly the wax is carved and smoothed, the less finishing of the surface of the celluloid will be necessary. The surface of the wax is then covered with heavy tin foil, which is burnished down lightly and smoothly.

The case is now ready for investing or flasking, after which the grooves are cut for excess of material; and in every case the parting of the flask should be at the edge of the wax, and the wax, teeth, and foil removed with the upper half of the flask, so that the surface of the model or cast is left clean and entirely exposed.

To prevent breaking a plaster cast, in cases of deep undercut, the method of investment suggested by the late Dr. Wildman should be followed. "It consists simply in so investing the cast that it shall occupy the position shown in Fig. 1006. If so placed, the pressure applied in moulding is brought to bear upon the mass of plaster supporting the projection, instead of upon a thin section." Cutting away the base of the cast at the heel before investing it will elevate the anterior part in the manner referred to. After the sections of the flask are separated, the wax is removed by pouring boiling water upon it from the spout of a kettle, when the tin foil will remain upon the plaster surface. In some cases it may be necessary to cut away the thin edge of plaster which projects over the mould in the section of the flask containing the teeth. It is recommended to cut a groove for excess of material around the inside of the flask, about one-eighth of an inch from the model, and in this section of the flask, with no cross grooves connecting the main groove with the model, as is done in the case of vulcanite. All sharp edges of plaster liable to break off should be removed or rounded, and many prefer, especially when gum teeth are used, to cut away the plaster between the model and the edge of the flask all around, about the thirty-second of an inch, to allow the surplus celluloid to escape without pressing too much upon the gums of the teeth. In using a celluloid blank care should be taken to select one as near the size of the surface of the model as possible, for all folding owing to too great width at the sides will form creases in the plate; the blank may be reduced to a proper size by cutting down. Celluloid may be moulded with steam, glycerine, or oil, and by dry heat, the latter giving the most perfect results. Fig. 1007 represents a sectional diagram of the

steam moulding apparatus of the Celluloid Manufacturing Company.

In using this steam apparatus the boiler is partly filled with water, the quantity being sufficient to cover the ribs at the bottom. The screw is turned back so far that the plunger when in position is resting against the top of the boiler, so that the model may not be injured by pressure upon the flask while the cover is being screwed down. It is very necessary that the cover should be well turned

FIG. 1007.

down, the gland turned back, and the screw working easily, otherwise it is impossible to determine how much pressure is exerted; for, if too much, the teeth or model may be broken, and if too little, the result is a porous plate. After the flask is placed in the apparatus the screw is turned down very gently with the thumb and finger, until it is felt to touch the flask. The heat, which may be generated with alcohol, kerosene, or gas, is then applied. The upper

portion of the safety valve, which consists of two parts, may be suspended by the pins in the lead weight, and this valve should not allow the steam to escape at a temperature of 225° F. When the steam begins to blow off, strict attention is necessary, as the plate is readily injured by too much heat without the required pressure. The time necessary from this point, with the properly regulated heat, is from fifteen to twenty minutes. When the steam escapes from the valve, its upper portion being suspended, the plate begins to soften, and the screw is easily turned with the thumb and finger, when the upper weight should be dropped down. The screw is again turned very carefully, the pressure ceasing as soon as resistance is felt, and continued when it again yields. This careful screwing down is kept up, and the pressure somewhat increased as the steam rises, which can be determined by raising the valve, the object being to exert an equal pressure over the entire plate, before the steam blows off very sharply and continuously on raising the safety valve. At this point in the moulding process the pressure should be increased, but an interval elapse between the turns of the screw in order to allow the celluloid, which flows very slowly, to escape under the pressure. At the end of the process, considerable pressure should be exerted by means of the screw, as much, indeed, as can be applied, or until the screw can no longer be turned. If alcohol is used to generate the heat, the cup of the apparatus is of such a size that its contents are consumed by the time the steam blows off from the safety valve, and the moulding is completed. If gas or kerosene is employed, the flame should be so regulated as to complete the moulding process within thirty to forty minutes, otherwise the celluloid may be injured.

To mould celluloid in glycerine or oil an apparatus represented by Fig. 1008 is employed. It consists of an open tank to contain the glycerine, with a thermometer to indicate the heat, a stand on detachable legs, and a screw-clamp to hold the flask. In the use of the glycerine apparatus, when the case is ready for moulding, the celluloid blank is placed in the flask, which is then put in the screw-clamp, and the screw turned until it lightly presses upon the top of the flask. The whole case is then placed in the tank and sufficient glycerine poured in to cover the flask—about one and a half pounds.

The heat (which may be generated by alcohol, gas, or kerosene) is then applied, and as soon as its effect is felt by the screw yielding to slight pressure, about 225° F., the moulding process is commenced. The screw should be very gently turned at first, and the pressure regulated by the softening of the celluloid, and increased

as the flask closes. The flask in the clamp can be removed from the tank at times to note the progress of closing of the flask, which should take place evenly, so as to distribute the pressure equally over the entire plate. The heat should not rise above 280° F., and if the flask is not closed completely when this temperature is reached the flame may be reduced. Olive or lard oil may be used instead of glycerine, but the latter is preferable on account of clean-

Fig. 1008.

liness. In using steam or glycerine, the flask should remain in the clamp until it has become cold; the cooling may be hastened by immersing the clamp and flask in cold water. Where the plate is of unusual thickness, or the blank is changed in shape to accommodate it to the case, it is recommended to place the flask, secured in a clamp, near a stove, at a temperature not exceeding 140° F., for at least half a day, in order to avoid the danger of warping the plate. It is also necessary, in the use of the steam apparatus, to put sufficient water in the heater, as too small a quantity may be entirely converted into steam, which is liable to become overheated, a result which is not only dangerous, but injurious to the celluloid.

In moulding celluloid by means of hot, moist air, several forms of apparatus may be used, one of the most prominent of which is the "Best." Hot Moist Air Celluloid Apparatus, represented in Fig. 1009.

In using the "Best" apparatus, the plaster in the flask should be

made very wet by placing it in a flask of water before it is put into the heater. After this is done the flask is placed in the clamp, the top of which is screwed down until it comes in contact with the flask. It is then placed in the oven of the heater and the heat applied, the degree of which is determined by moistening the end of the finger and applying it to the flask. When it fizzles on contact, as a sad-iron does to the finger of a washerwoman, the flask is screwed together.

FIG. 1009.

RIGGED FOR GAS. RIGGED FOR KEROSENE.

The point of a knife inserted between the edges of the flask will also determine the condition of the celluloid at this stage; also by experience in screwing down the flask. More pressure is applied as the celluloid softens or flows, allowing some little time to elapse between the turning of the screws, until the sections of the flask are brought together, when the heat is removed in order to avoid injuring the plate by making it porous. In the use of this apparatus the edges of the flask must not be pressed together until the celluloid is sufficiently softened to flow; and, on the other hand, the sections of the flask must not be kept apart too long or the plate will become hard from the evaporation of the camphor and obstruct the proper closing. The case is then removed from the oven of the heater and allowed to cool gradually, until it becomes quite cold.

For moulding celluloid by dry heat, which is now considered to be preferable to either steam or glycerine, the New Mode Heater, represented by Fig. 1010, was the first apparatus invented which possessed superior advantages over the others used for the purpose,

FIG. 1010.

RIGGED FOR GAS.
Can be adapted for alcohol by substituting the lamp for the gas burner.

GAS BURNER.

ALCOHOL LAMP.

and also for vulcanizing rubber. It is a cylindrical-cast vessel, having two chambers, one within the other, the inner one being supported by piers or columns connecting its sides, top, and bottom with those of the outer chamber, the whole being made in one

casting. The outer compartment is the steam-chamber or boiler, and incloses the hot-air or packing-chamber on all sides except the front, where the walls of the two chambers converge and become one, for the purpose of permitting access to the packing-chamber. A door, made of the same metal as the boiler, and fitted with lead packing to make it steam-tight, is held in place by a bridge secured with screws. The door is also provided with a plate-glass light (shown in cut), through which the operator can watch the progress of the moulding in the oven. The only communication between the two chambers is by means of a valve having its seat in the top of the packing-chamber, and controlled by a hollow stem which passes through the top of the machine.

B is a mercury bath; C, thermometer; D, screw-plug; E, lamnut; F, stem of steam-valve; G, screw-cap; H, large screw for closing the flask; I, I, I, smaller screws for the same purpose; K, K, K, L, nickel-plated caps for screws; O, O, steam-chamber.

The New Mode Heater, Seabury's and Evans's Vulcanizers (Fig. 1010) combine in one apparatus important improvements in the means of working both celluloid and rubber, that cannot fail to commend them to the favor of the profession.

It is the conviction of the inventors, which is sustained by the experience of many experts in the use of both substances, that *perfect* work in either can only be made in a dry chamber, and that where a high degree of heat is used, such as is absolutely essential in the manipulation of celluloid, the temperature must be kept uniform until the work is complete, and must not be allowed to change suddenly.

Steam is used in these machines to heat up the packing-chamber and investment, but the chamber itself can be, and for certain kinds of work must be, kept absolutely dry after the moulding commences, while the complete control which the operator has over the workings of the machine enables him to maintain the heat at any desired temperature. The hot-box or packing-chamber is nearly, in one, and in the others quite, surrounded by the boiler, and steam may be admitted to or excluded from the packing-chamber at will. A case may be removed from the heater and another one inserted without reducing the temperature or letting off the steam from the boiler, thus accomplishing a large saving of time. The boiler has no steam-packed plunger or screw to cause uncertainty as to the amount of pressure applied. The top of the boiler, in the case of the New Mode Heater, is cast in one piece with the boiler; the flask is closed with a small key-wrench by the thumb and finger, the screw-bolts for closing the flask passing through the steam-chamber in

piers or columns; a steam-tight plate-glass door permits the operator to examine the work at any time during the process of moulding, enabling him to apply the proper pressure at the right time, thus reducing the liability to break the cast, investment, or teeth. The descriptions of the Seabury and Evans machines, in the article on Vulcanite, will explain their manipulation.

Dry heat has no injurious effect on the celluloid material. If a piece of transparent celluloid be passed through a jet of steam, the transparency will disappear in an instant, and the material will become opaque and lose its hardness. A piece of the same transparent celluloid heated in a dry chamber to the same temperature as that of the jet of steam is not affected, its transparency and hardness remaining unchanged. So, too, a piece of black rubber vulcanized by dry heat is of a pure jet-black color when taken out; while a piece of the same black rubber vulcanized in the ordinary method shows brownish discolorations. These simple experiments show conclusively that the action of the steam is the cause of the loss of quality. Dr. Campbell gives the following directions for the moulding of celluloid in his apparatus, which are also applicable to the others:—

To secure the best practical results, celluloid should be moulded or pressed into the form desired at the highest possible temperature which will not burn it. To prove this it is only necessary to mould a plate on a metal cast at the lowest temperature at which it can be done, which is less than 212°, and another on the same cast at the highest temperature possible, say 310° or 320°, and lay the two aside for a few days, when it will be found that the one moulded at the lower temperature will not fit the cast, while that moulded at the higher temperature will fit as well as when first made. The reason is that the low temperature fails to overcome the tendency of the plate to return to its original form, while the high temperature renders it so thoroughly plastic that this tendency is entirely eradicated. This is proportionally the case with pieces made at intermediate temperatures; the higher the temperature to which the plate is subjected in moulding, the more exactly will it hold its new form and the less will be its tendency to warp.

Celluloid may be readily and safely manipulated in the New Mode Heater at 320°, a temperature many degrees higher than is deemed safe in other machines, and which accomplishes perfectly the result above noted, and produces a plate which is believed to be absolutely unchangeable in color, form, and texture. When this very high temperature is employed the celluloid should be in the machine only long enough to permit the closing of the flask; for the reason

that heat vaporizes the camphor—the solvent of the material. If too much of this is driven off before the flask is closed it will be almost impossible to mould the blank to the desired form. The sooner the flask is closed after being placed in the oven, the more readily it will be done and the better will be the result.

The moulded surface of a piece of celluloid is much more durable than its interior, and will retain the color better. It is obvious, therefore, that this surface is essential to the integrity of the plate and should be preserved intact. To insure this, the case should be so prepared that the plate, when taken from the flask, will require little or no labor to make it ready for use. It is possible that some surplus material at the edges may have to be trimmed off and the edges smoothed, but the case is not properly prepared if more than this is necessary. The care and trouble involved in proper preparation will really save time, will absolutely avoid interference with the fit by the too free use of files, sand-paper, pumice, etc., and will insure a durable plate with a permanent imitation of gum-color. Moreover, the artistic taste of the operator may be exercised before the plate is moulded more readily than afterward.

Paraffine and wax compound is used for the base plate, according to directions before given, and the teeth arranged, the wax carved into the shape desired by means of carving tools, and made smooth. The piece is then invested in plaster, the usual grooves cut, the wax teeth and tin foil being removed with the upper half of the flask in parting. The wax is then removed by means of boiling water, as before described, the tin foil, No. 60, used for covering the paraffine and wax plate remaining upon the plaster, and the investment is now ready to be dried out preparatory to receiving the celluloid.

Drying the Cast and Investment.—To dry a plaster cast and investment, and keep them free from cracks and checks, is very difficult by the ordinary means, but with the New Mode Heater it can be done so perfectly as to permit their use in casting pure gold or gold alloys.

There are two ways of drying the investment in the New Mode Heater: first, by raising the temperature to 320°, keeping the hot box dry; second, by admitting steam to the hot box. The former method can be used when the investment is placed in the chamber before getting up steam. If steam is up, however, either method may be employed. In using the dry heat method, open very slightly the screw cap of the piston or valve stem, to permit the escape of the steam generated from the water in the plaster, being careful that the steam valve is firmly seated, as otherwise all the steam made in the boiler will escape. In using steam for drying, admit the live steam

into the chamber with the investment by raising the valve from its seat, keeping the screw cap closed. The steam quickly permeates the plaster, and in five or ten minutes the temperature of the plaster is high enough to convert the water in it into steam. As soon as the plaster is thoroughly heated, shut off the steam by closing the valve, and raise the screw cap very slightly, to allow that in the chamber to escape slowly through the small aperture at the side of the screw. In a few moments the cast will be perfectly dry, the steam escaping from the chamber, carrying with it that generated from the moisture in the plaster. Extreme care should be taken that the steam shall escape *very slowly*, as otherwise the plaster may be blown out of the flask into the oven by the too rapid expansion of its vaporized moisture. The completion of the drying process is known by steam ceasing to be given off at the screw cap, G. The drying may be facilitated by placing a small chip of wood between the two parts of the flask when it is put into the chamber, thus exposing a larger surface to the heat and allowing the moisture to escape more readily.

Moulding by Dry Heat.—When the investment is dried, remove it from the chamber and insert and carefully adjust the selected blank; replace the flask in the oven immediately under the screws; see that the two sections are so placed that the guide-pins will enter properly into the lugs; open the screw cap a turn or two to allow the escape of the gas from the hot box; turn down the large screw until it bears lightly upon the top of the flask, and close the machine. In less than five minutes the material will be sufficiently softened to permit the commencement of the moulding. The screws will turn readily with the thumb and finger (using the smaller key-wrench) when the blank is properly softened. Close the flask gradually, stopping occasionally if the resistance is too great. Usually, if the temperature is about 300°, the flask can be closed in ten minutes; but if a very thick blank is used, the moulding must proceed slowly; the small screws may be used to advantage, and more time, say thirty minutes, may be consumed. As soon as the flask is closed—unless a lock flask is used—the flame should be extinguished, the door opened, and the machine allowed to cool. If a lock flask is used, it may be removed and thoroughly cooled before opening it, the oven being meanwhile ready for another case. The cooling may be accomplished rapidly, if necessary, by placing the flask in water. When perfectly cold, remove the plate from the investment; it will be found enveloped in the tin foil which had been burnished to the wax plate. Peel off the foil. The celluloid will present a hard, brightly-polished surface, received from its contact

with the foil, *and will need no further finishing than cutting off the excess of material and smoothing down the edges.* The extra hardness of the *surface* will thus remain to preserve the integrity and color of the piece. It is claimed, also, that the contact of the foil renders the outer surface, which is always the densest portion of celluloid, much harder.

Imitating Gum Membrane.—The plate produced by the above method is of the ordinary appearance, with smooth, polished gum, but a much more natural, life-like gum will result if the tin foil, after being burnished to the wax plate, is "stippled." This is done by "dotting" carefully over its surface with a dull-pointed instrument, which should be held nearly perpendicularly to the surface to be operated on, and the strokes should be gentle—*not hard enough to perforate the foil.* When the foil is removed, after the case is moulded, the gums present an appearance closely resembling the natural membrane. The stippling need not occupy a great deal of time, and the result it produces is a marked improvement.

Metal Casts and Deep Undercuts.—Many dentists who prefer to use metal casts have doubtless found difficulty in removing the finished plates in cases of deep undercut. The fact that a melted metal cools from the surface toward the centre supplies an effectual remedy. When the metal is poured into the sand, allow it to chill only about a quarter of an inch on the outside, and then pour the balance out of the mould. This makes a hollow cast or shell. Fill up the cavity with plaster and proceed as usual. After the plate is moulded, remove the plaster, place the edges of the metal cast in the jaws of a vice, and crush the shell. This will free the piece without disturbing the teeth. The plaster in the shell also affords the means of attaching the cast to the articulator. A plaster core in the form of a cross may also be inserted when pouring the metal die in the base, which will divide the core into four sections, which may be crushed together in a vice and thus liberate the celluloid plate.

Repairing.—If a portion of a plate has been broken away and lost, fit a piece of celluloid of the proper shape, leaving it somewhat larger than the space to be filled. Make sure that the surfaces to be united are *perfectly clean;* even the perspiration from the hand may cause a dark line. Flask and mould as usual.

A crack in a plate or the parts of a broken plate may be joined by scraping the surfaces clean, or washing them with alcohol, and moulding a thin strip of celluloid into the seam.

The following method of repairing small breaks is suggested by

Dr. M. H. Cryer and possesses the merit of extreme simplicity, and its results are in the highest degree satisfactory :—

Remove all portions of the broken tooth from the plate, taking care not to disturb the outlines of the socket. Select a tooth of proper size and shade to replace the broken one. (If the tooth is numbered, a considerable part of the trouble of selection may be saved by taking the number of the mould from the reverse impression in the plate or from the broken pieces.) Having set the new tooth partly in its place, hold it steadily over the flame of an alcohol lamp, carefully guarding the celluloid from contact with the flame. In a few seconds the tooth will begin to grow warm, and its heat will soften the celluloid sufficiently to allow the tooth to be pressed into its proper position with a napkin. This will cause a small bulge or raised spot to appear in the celluloid opposite the lingual portion of the root of the tooth. Invest in plaster, in the deeper section of the flask, covering the whole plate and the teeth, except the small portion of the celluloid raised in pressing the tooth into place. Complete the investment, part the flask, and dry the case, after which insert a piece of rather thick writing paper or heavy tin foil over the raised spot and place in the oven. Heat up to the usual temperature for moulding and close the flask. When the case is cold the tooth will be found firmly fixed in its position, and there will be no mark to show that the plate has been repaired.

In case a small portion of the celluloid is chipped away from the front of the socket—enough only to expose the end of the root when in position—drop a little wax upon the vacant spot after placing the tooth and carve to the shape desired. Without removing the wax, invest and mould as before described. The wax will pass off into the plaster and its place will be supplied by the celluloid, of which there is usually enough to permit the flowing of the minute quantity required without damage.

If there is a similar deficiency on the inside of the plate, exposing the pins of the tooth, drop wax into the vacancy and proceed as before, except that in this case the wax is to be removed when the investment is made, and the bit of writing paper or tin foil is to be placed just below the pins, instead of over them, so as to force the flowing of the celluloid to cover them.

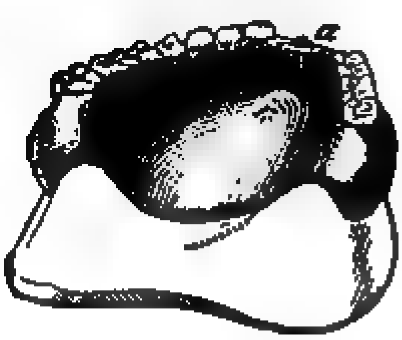
To remove a tooth from a celluloid plate, *hold* the outside surface of the tooth to be removed in the flame of the lamp until the heat softens the celluloid around the pins slightly, when it may be taken off without trouble, and it will come away clean, without any of the celluloid adhering to the pins. Do not move the plate back and forth through the flame, or other teeth than the one desired

may be loosened, or their perfect articulation may be interfered with. There is no danger of cracking the tooth so long as the flame does not come in contact with the pins.

Fig. 1011 represents the first process in repairing a celluloid plate from which a tooth or block has been broken. The plate being cut away sufficiently to allow the new tooth to be adjusted by grinding, a new piece of celluloid (*a*) is fitted to the space. The new piece is then removed and its place filled up with wax. Fig. 1012 shows the piece invested in the lower section of the flask, the space filled with wax being the only portion visible, the entire surfaces of the plate and teeth being covered. The upper section of the flask is then adjusted and filled up with plaster. When the flask is opened the wax is removed and the new piece of celluloid returned to its place, and upon it is placed another

Fig. 1012.

Fig. 1011.



small piece of celluloid, or a roll of tin foil, to produce pressure upon the new piece first added, the edges of which, as well as those of the space into which it is fitted, being moistened with spirits of camphor or liquid celluloid to bring about union.

Liquid celluloid is made by dissolving small pieces of celluloid in spirits of camphor. The piece is then placed in the heater and subjected to the usual process. Where the plate is of considerable thickness, a new tooth or block may be added without new material by cutting away as little as possible of the old plate on the lingual surface, and depending upon the thickness of celluloid pressing up, after being softened in the heater, closely to the new tooth. Loose teeth may be tightened in the same manner, wax being introduced into the vacant space and removed after the flasking.

Some object to the use of a solvent in repairing on account of the

liability of the newly-added material to become porous. To cleanse celluloid plates previous to repairing, they should be placed in a solution of whiting and water, to which is added some liquid ammonia, and allowed to remain some time, when they are brushed with soap and water, and finally washed in clean water and dried.

NEW MODE CONTINUOUS GUM.

With reference to the second objection to the use of rubber, it is to be said that the perfect reproduction of natural effects and really artistic work cannot be made with block teeth. To obtain the proper expression, each tooth should be available for placing in any position desired, instead of being arbitrarily held in association with others, as in a block.

The invention of the New Mode machine places in the hands of the profession the means for overcoming this objection by using plain teeth with rubber for the base, and celluloid, which is well suited for the purpose, for the gum, the combination forming an exquisite piece of work which the inventor calls the "New Mode Continuous Gum." It is easily the nearest approach to porcelain continuous gum that has been obtained with plastic materials. Its general adoption would do away with "bad joints" and broken blocks, which are so often a source of serious annoyance. It is the only rubber plate upon which a tooth may be replaced without revulcanization, and which after the repair is equal in strength and appearance to the original piece; and the only one upon which repairs can be repeated any number of times without injury to the original plate. This same style of work can also be done with gold and with cast-alloy plates.

Directions for Making the New Mode Continuous Gum.—Using teeth made expressly for continuous-gum or celluloid work, set them up in wax in the usual manner, leaving the front or outside of the roots exposed. Cut a thin strip of the wax, warm it, and attach it to the upper edge of the portion of the wax plate representing the gum, forming a rim which extends all around the outer margin. Finish the palatine surface to the form desired, invest in the flask in the usual manner, remove the wax, pack with rubber, and vulcanize. When removed from the flask the case will present the appearance shown in Fig. 1014, the front or outside of the roots being exposed and the narrow *undercut* rim extending all around, leaving a space with retaining grooves between the teeth for forming a gum of celluloid, looking very much as though the substance of the plate had been gouged out for the purpose. The vulcanite plate is now completed with the teeth firmly attached to it.

Fig. 1013.

Fig. 1014.

Fig. 1015.

Fig. 1016.

To put on the gum, fill up the groove with paraffine and wax (this compound, not being sticky, does not adhere to the instrument and is therefore more easily carved to the form desired) until all the space inside the rim, including the retaining grooves between the necks of the teeth, is occupied. After the wax has hardened, which may be hastened by placing in cold water, carve it into the desired form of gum. The wax may be made very smooth by throwing upon it the flame of a spirit lamp with the aid of a blowpipe, taking care not to destroy the outline of the carved gum. Cover the wax with heavy tin foil, burnishing it lightly but smoothly to the wax.

Invest the piece again in the following manner: Place the plate in one section of the flask with the teeth upward, and raised at the front at a greater or less angle, as may be necessary, so that when the investment is completed the upper part of the flask may be removed without dragging. Imbed in plaster to the rim and pour plaster over the palatine surface, covering the crowns, and taking care to fill the interstices between the necks of the teeth, but leaving their outer surfaces exposed. After the investment sets, pour more plaster around the inner edge of the flask ring, forming a ridge, leaving a groove or space between it and the plate. (See Fig. 1016.) Complete the investment and remove the wax from the groove and interstices between the roots of the teeth by pouring boiling water over it. Having selected a celluloid blank of proper size, saw off the outer rim (see Fig. 1013); warm this rim of celluloid in boiling water, and with the hand and a cloth press it closely about the teeth and hold it to its place until stiff; it will then remain there until the two parts of the flask are entered upon the guide-pins. Join the two parts of the flask together and place the investment in the oven of the machine, having previously heated up the chamber. When the temperature of 280° is reached the flask may be closed. As soon as this is accomplished the case is ready to be removed from the oven and placed in a clamp to cool.

When perfectly cold remove the plate. The tin foil will adhere to it, but it can be readily removed by inserting the point of a knife under the edge and pulling it off, leaving the surface of the celluloid gum as smooth and polished as that of the foil.

A surface produced by the above method presents a smooth, polished gum, but if the tin foil is "stippled," as before described, a striking resemblance to the natural membrane will be produced, the finished plate presenting the appearance shown in Fig. 1015. The adjoining edges of the celluloid and rubber will be found perfectly united, each preserving its sharp outline.

Dr. D. Genese recommends the following method of working celluloid, which will give a hard, smooth, polished surface to the plate when it leaves the heater, regulate the size of the celluloid blank before it is moulded to the surface of the metal die or cast and about the teeth, and also form a metal cast, which is easily removed from the celluloid plate after it is completed:—

Two perfect impressions in plaster are taken of the mouth, one of which is used to secure a plaster model, upon which the trial plate is formed, of wax and paraffine. Upon this trial plate a rim of wax is built, and the exact bite secured. In wax, only the model of the piece desired in the finished case is then formed, which is attached to a metal die, which has been obtained by moulding the plaster model in sand. The whole is then moulded in sand, and a zinc and lead die and counter-die obtained, by means of which a tin cap (made of rolled tin, No. 29 gauge) is swaged, which will completely envelop the wax model, extend over the gum portion, and to the full height of the finished "bite." The edge of the tin cap, which is left rough, is turned up at an angle of about forty-five degrees, so as to form a support for it in the plaster, when it is invested. The object of this cap is to form a metal mould in which the celluloid blank can be shaped to the form and size desired for the case in hand. The modeled wax is then transferred to the plaster model, which is invested in the lower half of the flask, and the surface of the investment varnished over and oiled, to ensure the required separation. The tin cap is then placed over the modeled wax surface and the upper half of the flask filled with plaster. When the flask is separated, the wax is removed from the plaster model, the tin cap remaining firmly secured in the upper half of the flask. The celluloid blank is then placed in the tin cap mould, and the sections of the flask brought together by being placed in a heater. Upon removing the blank from the mould, in the flask, any excess of celluloid can be removed, and a blank of a proper size and form secured which will not press the teeth out of position in the subsequent moulding of the plate. It is necessary to secure a duplicate bite to mount the teeth, which is done on a metal die or cast, formed as follows:—

The second plaster impression is removed from the impression cup and imbedded in a sand and plaster investment as deep as it is desired to have the cast. A right-angle cross, with arms about half an inch wide at the upper surface and tapering to a sharp edge (△), is then made of plaster mixed with sand and placed over the surface of the plaster impression in such a manner as to bring the sharp edge almost, but not quite, in contact with the impression

surface, where it is secured by sealing the ends of the arms to the margin of the impression. A metal die or cast made in this manner is divided into four sections by the cross-core, very nearly to its surface, and is more readily removed from the celluloid plate after it is moulded than the hollow metal cast, as the removal of the plaster core will permit of the sections of the cast being bent away from any undercuts which may exist. After obtaining the form of metal die described, the teeth are mounted upon a trial plate formed over it and according to the duplicate "bite," and the new wax plate is modeled into the form desired for the finished celluloid plate. An impression in sand of the whole is again obtained, a zinc die and lead counter-die poured, and a tin cap similar to the one first made is swaged. This tin cap forms a complete metal casing, and on flasking, is secured in the upper half of the flask by means of its turned edges. The case is then flasked in the usual manner, and on separating the sections and removing the wax the celluloid blank, which has been previously moulded into form, according to the manner described above, will be found well adapted to the mould. The case is then placed in one of the combination heaters and moulded at a temperature of 300°, which should never be exceeded; and no pressure should be applied by the screws until this heat is obtained. The construction of partial sets is more difficult, but the process is the same as for entire dentures, a cap of somewhat lighter tin being used. By this process the edge only of the plate and a slight excess of material about the necks of the teeth require trimming off, the entire surface being polished without any scraping away by first using fine pumice and glycerine, and finally whiting and glycerine. The plate should be thoroughly cleansed, after removing it from the flask, of all particles of plaster that may adhere to it, and the entire manipulation be conducted with clean hands and instruments.

A metal cast somewhat similar to the one above described may be made by first moulding in the usual manner, and afterward sawing all around the alveolar ridge with a fine saw, leaving only what will hold the parts together. Plaster is poured into the spaces made by the saw, in order to render the cast solid. When the set is finished the plaster is removed from the spaces and pressure made by a vise upon the edges of the cast, so as to crush them in and thus free the plate.

Dr. M. H. Cryer devised the filing of notches in celluloid blanks as in Fig. 1017, when the counter-sunk tooth-crowns are to be mounted in this material. The suggestion obviates the defects found to attend the mounting of these teeth in the usual way, for the con-

fined air in the cups commonly prevents the celluloid from entering far enough to more than half fill them, and thus the pins are left untouched. As a consequence the teeth come off in the process of finishing; or, Fig. 1018 shows the effectiveness of the plan which provides for the escape of the air, while the plastic promontories enter the countersinks and surround the pins, by means of which the teeth are firmly secured to the plate, on which they thus have so strong a hold that the labial necks of the crowns may, for conformity to the adjacent natural teeth, be quite uncovered by the celluloid (see Fig. 1019), and the mounting be yet a strong one, as is evidenced by the section through plate and crown, Fig. 1020, which illustrates a countersunk tooth crown. In this instance the short

FIG. 1017.

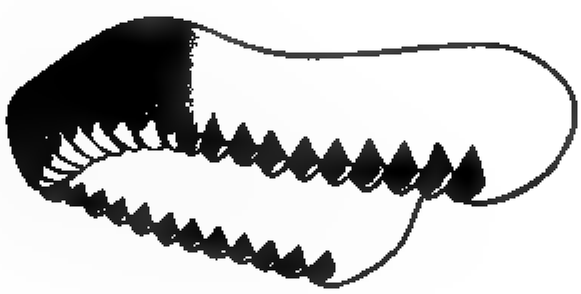


FIG. 1018.

FIG. 1019.

FIG. 1020.

celluloid festoons (see Fig. 1019) lie close upon the gum, which they much more nearly resemble than the dark vulcanite when such a base is made.

When the celluloid blanks are moulded upon plaster surfaces, files, scrapers, and fine sand or emery paper are necessary in the finishing process, completing the operation of polishing with whiting or prepared chalk, applied by means of a soft brush wheel. Camphor, applied on a soft cloth, is also used to obtain a polish, especially between the teeth and other places beyond the reach of the brush wheel. Friction with the brush wheel sufficient to heat the plate should be avoided, on account of the danger of changing the shape of the plate and injuring the surface. Dark lines on celluloid plates are often the result of using blanks too wide for the case or too thin in the centre, causing the celluloid to press toward the middle of the

plate and fold upon itself. Where the arch of the mouth is very deep, the pressure by means of screws should not be applied before the blank is well softened by the heat, otherwise it may tear apart. Too little pressure, or too little material, may cause a porous plate; also overheating in the dry heat apparatus; the same condition in steam heating may result from too little pressure at the proper time. If the temperature of a celluloid plate is raised to 270°, without any pressure being brought to bear upon it, the material becomes puffed up and is ruined in texture, and cannot be restored by any subsequent manipulation. Celluloid flows very sluggishly, hence sufficient material must be present to insure a perfect plate. The celluloid blank may be softened in boiling water and formed into any desired shape, and an excess at any point may be removed with a sharp knife. It should be remembered that there is no union between celluloid and rubber, hence when one of these materials is added to the other, it can only be done by dovetailing or drilling holes. Good, hard-setting plaster should always be used in working celluloid, and it should be well mixed by adding it to the water in such a manner that all is absorbed that it will take up. Care should also be taken not to mix the plaster too thin or to use very fine plaster, as a course grade of strong plaster will give better results. Some are in the habit of adding clean white sand or marble dust to the plaster. The following directions are given in the use of the New Mode Heater, which will prove serviceable in the working of celluloid generally:—

Always use good plaster, and do not mix too thin; always select a blank which nearly fits the cast, with an excess in *every part;* always turn the screws as soon as they will yield to the thumb and finger, and *always* gently; always follow up the rise in temperature with increased pressure; always give the material plenty of time to flow between the turns; always increase the pressure toward the close of the moulding; always reduce the temperature of the piece at once after the completion of the moulding, and keep the plate under pressure until it is stone cold.

ZYLONITE.

A modified form of celluloid has been introduced under the name of *zylonite*, the working results of which appear to show a great difference in quality. Zylonite, like celluloid, is composed of pyroxylin and camphor, but in different proportions, being, it is claimed, a chemical combination, while celluloid is a mechanical mixture.

Possessing translucency, the effect of zylonite in the mouth is very pleasing, and, so far as it has been tested, promises to be more durable than celluloid, without the tendency to warp or to change color when ordinary care is taken in its manipulation, which is the same as for celluloid. The zylonite blanks are uniform in color, and although this material requires the same amount of pressure to mould, it flows with a more perfect sharpness of outline than celluloid, and apparently does not disiutegrate.

CHAPTER XVI.

PORCELAIN TEETH.

As Pharmacy was once a part of Medical Practice, and instrument making a part of Surgery, so the manufacture of porcelain teeth was at one time confined to the dental laboratory. Until within the past thirty years a practical knowledge of the Dento-ceramic art was considered an essential part of dental education. Galen compounded his celebrated *Theriaca* for two Roman emperors; Paré and Wiseman made many of their surgical instruments; and necessity has compelled physicians and surgeons in all ages to imitate these examples. But the medical and surgical world have for many years committed the manufacture of drugs and instruments to those who, by making it a special art, can produce far better results.

The time has fully come when Dentistry should do the same with porcelain work, for two sufficient reasons: 1. Manufacturers now offer to the profession porcelain teeth in such variety of beautiful forms that not one dentist in a thousand could equal them. 2. Moderate proficiency in block-carving requires such an amount of preparatory training and of continuous experience, that the dentist's education and practice must suffer in the line of important duties which cannot thus be delegated to others. Hence, nearly, if not quite all, of the most skillful block-carvers engaged in the practice of dentistry have, since the year 1850, one after another, given up this art, which it cost them so much to acquire. For these reasons, and also because the management of a porcelain furnace cannot be taught in books, we shall not attempt in this chapter to give a full and didactic exposition of the manner of making porcelain block or single teeth. Those who desire such knowledge with a view to making it a specialty, require that which no longer comes within

the scope of a work on the "Principles and Practice of Dentistry" to teach.

There is, however, on the part of all students, and probably of most practitioners, a desire to know the composition of dental porcelain, and to have some idea of the manner in which a few earthy materials and metallic oxides are made to assume such beautiful forms. Some knowledge of the component parts of porcelain is essential to a correct understanding of the necessity for their admixture, as well as of the effects thus produced.

PORCELAIN MATERIALS.

The infusible earths, Silica and Alumina, and the fusible alkalies, Potassa and Soda, form the bulk of all porcelain. Certain metallic oxides, in small quantity, give color, and some varieties of pottery are modified by small proportions of Lime and Magnesia. Dental porcelain is made from the purest compounds of silica, alumina, and potassa, colored by metallic Gold and Platina, and by the oxides of Gold, Titanium, Manganese, Cobalt, and Uranium.

SILICA.

Silica (quartz, silex, silicic acid) is, next to oxygen, the most universally diffused substance in nature, constituting 50 per cent. of all rocks. Granite, granitic rocks, sandstones, and sand contain not less than three-fourths silica; mica, schist, clay-slate and clay, not less than two-thirds; trap-rocks and lava, one-half. Silica is to the mineral kingdom what carbon is to the vegetable—the element of stability. In its purest forms (rock crystal, Brazilian pebbles, or crystals of quartz), it is free from discoloration by iron or other oxides, it is absolutely infusible, and is insoluble in water; this is the kind selected for dental porcelain, but for other varieties of porcelain flint is commonly used. It forms silicates with alumina, magnesia, lime, potassa, and soda, the most important of which, in this connection, are the silicates of alumina and potassa. Silica, as found in feldspar and kaolin, is partly pure silica, partly the silicate of alumina. Now the "behavior" in the furnace of silica and the silicate of alumina is different; hence, chemical analysis can estimate only the relative purity of these substances; experiment alone can determine the proportions of each necessary for the development of any required property in porcelain.

FELDSPAR.

Next to silica, alumina (oxide of aluminium) is the most universally diffused of all minerals; but, unlike silica, it is rarely found

uncombined. The gem Sapphire is pure crystallized aluminium, and is the next hardest mineral to the diamond; a less pure form is well known in dentistry as emery or corundum, some specimens of which seem, under the lens, to be a collection of minute crystals of dark-colored sapphire. For porcelain manufacture, aluminium is never used in its purest state, but in its natural combinations with silica, lime, potassa, and soda. For dental porcelain only two of these are used—Feldspar (known to the Chinese as Pe-tun-tse) and Kaolin. Feldspar is a silicate of aluminium and potassa, containing a little lime and a trace of iron. A less common variety of spar contains soda in the place of potassa; it makes a soft porcelain, fusible at lower heat than the potash spar. Lime feldspar is used in some kinds of pottery, but for dental purposes potash feldspar is the only variety. It is an abundant mineral, and is often found in large masses; the purest varieties alone are used for dental porcelain. Delaware and Pennsylvania spars are most esteemed by American manufacturers. Its most extensive dissemination, however, is as one of the components of granite and granitic rocks, by disintegration of the feldspathic constitutents of which large beds of porcelain clay are formed, as found in China and Japan, England, Germany, and France, and also in the United States.

KAOLIN.—Ka-o-lin (the Chinese word for clay) is the purest of these mixtures of silica and silicate of alumina, prepared in Nature's laboratory for the manufacture of porcelain. Pipe clay, potter's clay, blue clay, fire clay, and Cornish stone are similar in composition, but only the purest kaolin is used for dental porcelain. It contains nine parts of silica and eight parts aluminium; whereas spar has nine parts silica and only two parts aluminium; also spar is made fusible by its silicate of potassa—kaolin has none. Kaolin is, therefore, feldspar deprived of its soluble silicate of potassa (or soda), which has been washed out during the disintegration of the feldspathic rocks. It is soft and unctuous, and is highly plastic; pulverized spar, on the contrary, is granular or powdery, and is moulded with difficulty. Kaolin, like silex, is infusible; under intense and continued heat it shrinks greatly and becomes extremely hard, but it is always porous and absorbent. Silex lessens the contraction of kaolin, spar gives it fusibility; both diminish its absorbent quality, so objectionable in any material that is to be worn in the mouth.

Stone ware, China ware, Wedgewood ware, Parian porcelain, and Dental porcelain vary in their properties because of the different proportions in which kaolin and feldspar are combined, also in the kind of flux used. For instance, the Parian statuettes have kaolin

and spar in equal proportions, with about half as much of a flux, made of spar, quartz, and potash. Dental porcelain, demanding less heat, less shrinkage, and a more translucent appearance, has a very much greater proportion of spar. It has required a very extended series of experiments to combine silica, aluminium, and potassa in correct proportions, and to know just which of Nature's compounds it is best to use in order to harmonize the requisites of strength and beauty, so essential to the character of a porcelain tooth.

COLORING MATERIALS.

The foregoing materials give a pure white porcelain of greater or less translucency. It is now required to find substances which will, in the strong heat of the furnace, yield indestructible colors, by skillful combination of which the porcelain may imitate the almost endless varieties of tint in the natural teeth and gum. Of these there are three principal colors and three subordinate ones.

TITANIUM.—The purest varieties of the oxide of titanium are selected; it is found as a mineral in various localities throughout the United States. The crystals are reddish-brown, and have a bright, metallic lustre; they give, when ground, a beautiful yellow, or yellowish-brown color. It is used in the coloring of all *body*, and is the basis of color for the class of yellowish *enamels.*

PLATINUM.—This metal, precipitated from its solution in aqua regia, then washed and dried, is known as platina sponge. It gives a gray-blue color, and is the basis of color for the class of grayish-blue enamels.

GOLD.—Gold precipitate is used to give life and animation to the tooth, producing often a very remarkable effect. The oxide of gold, known as *Purple of Cassius,* and generally considered to be a mixed oxide of gold and tin, is used to impart the well-known red color of the artificial gum; no less costly substitute has ever been found for this purpose.

Oxide of Manganese gives a purplish color, and is used occasionally for some shades of tooth, but not of gum. *Oxide of Cobalt* gives a bright blue color. If wrapped in best blue paper and burned in a covered crucible it is called the ashes of cobalt, and is thought to give a more desirable tint to the enamel than the simple oxide. *Oxide of Uranium* is used in its mineral form and gives a greenish-yellow color; while a lemon-yellow color may be given by the *oxide of silver;* but this is a fugitive color at high temperatures.

These colors, singly and in combination with each other, produce a great variety of colors or shades. Thus, say forty shades of *body color* are made by using these materials in different quantities and in

different combinations; also a like number of *enamel colors.* Then, starting with the lightest shade of body, forty different grades may be produced by using a different point enamel; so of each of the forty shades of body, making, if required, sixteen hundred variations of shade.

The following formulas will suffice to give a correct idea of the proportions in which the preceding materials are combined to give the BODY and ENAMEL of porcelain teeth, single or in sections:—

BODY.		ENAMEL.	
Feldspar,	12 oz.	Feldspar,	8 oz.
Quartz,	2 oz.	Sponge platina,	1 to 4 grs.
Kaolin,	15 dwts.	Flux,	8 dwts.
Titanium,	24 to 48 grs.		

The FLUX here mentioned is made by fusing four ounces of finely ground quartz with Glass of Borax and Sal Tartar, each one ounce; it forms a transparent glass. The following formulas show the preparation of Gum Enamel:—

GUM FRIT.		GUM ENAMEL.	
Oxide of gold,	10 grs.	Gum frit,	1 oz.
Feldspar,	1 oz.	Feldspar,	8 oz.
Flux,	8 dwts.		

The titanium, platina, and oxide of gold must, in these recipes, of course, be modified by mixture with other colors to produce the requisite varieties of shade.

BODY FOR MOULDED BLOCK TEETH.

No. 1.		No. 2.	
Kaolin,	1 oz.	German clay,	½ oz.
Silica,	8 oz.	Silica,	8 oz.
Feldspar,	18 oz.	Feldspar,	18 oz.
Oxide of titanium,	65 grs.	Oxide of titanium,	65 grs.
Starch,	10 grs. to each ounce.	Starch,	10 grs. to each ounce.

BODY FOR CARVED BLOCKS.

No. 1.		No. 2.	
Kaolin,	1 oz.	German clay,	½ oz.
Silica,	8½ oz.	Silica,	8½ oz.
Feldspar,	14 oz.	Feldspar,	14 oz.
Oxide of titanium,	40 grs.	Oxide of titanium,	40 grs.

BLUE ENAMEL.		YELLOW ENAMEL.	
Platinum blue frit,	1 gr.	Titanium,	1 gr.
Feldspar,	1 oz.	Gold frit,	2 grs.
Starch,	15 grs.	Starch,	15 grs.
		Feldspar,	1 oz.

We shall now briefly describe the processes by which the porcelain teeth and sections sold to the profession are manufactured.

PROCESS OF MANUFACTURE.

The silex and feldspar, in their crude state, are first submitted to a red heat, then suddenly thrown into cold water. This is called "Calcining," and the effect is to render them more easily broken and pulverized. All impurities having been carefully removed, they are crushed between flint stones; when fine enough, they are put into a mill, formed of burr millstone, with chasers of the same material. They are ground in water, then floated off, and allowed to settle. The water is then drawn off or evaporated; the silex and spar, dried and sifted, are then ready for use. The kaolin, having been already pulverized in Nature's laboratory, is prepared by washing until perfectly free from impurities, and when dry is ready for use. The flux and frit are coarsely ground, but the coloring materials are reduced to an impalpable powder. All these porcelain materials are combined in proper proportions to form the body and the enamel, then mixed with water and worked into masses resembling putty. When, however, the method of *biscuiting* is adopted the enamels are mixed in a much thinner state than the body.

The unbaked porcelain masses are now ready for the moulding room. The moulds in which single teeth or sections are formed are made of brass and are in two pieces—one-half of the tooth being represented on either side. The precise shapes desired are carved out with great care; holes are drilled to receive the platina pins in each tooth; when the two halves are fitted accurately together, with guiding pins for exact closure, the mould is ready for use. The brass matrix must be made about one-fifth larger than the size desired, to allow for shrinkage of the porcelain paste. After greasing the moulds, the first operation is, by means of small tweezers, to place the platina pins in the holes made for them (there are many sizes of these pins, differing in length and thickness, to suit the different sizes of the teeth). As no piece of mechanism can be stronger than its weakest point, there should always be such a relation between the tooth substance and the pins, as to shape, size, and angle of insertion, that one will be as strong as the other, and both sufficient for all legitimate uses. The strength of pin, without loss of strength in the tooth, characterizes a recent and valuable improvement made by the late Dr. S. S. White, and known as the "foot-shaped pin," illustrated in Fig. 1021. The thickest part of this pin is at the angle, or heel; the point, or toe, runs upward into the thick part of the tooth, giving additional security against its being drawn out. The

insertion of the pin at an upward angle beds it in the strongest portion of the tooth material; thus any weakening of the thin portion of the tooth is avoided, as when the headed pin is inserted in a straight line; also, the greatest amount of material is found where the greatest strain is brought to bear upon it. The force of mas-

FIG. 1021.

tication is exerted outward and toward the necks of the teeth; thus the shape and direction of this pin are best calculated directly to oppose it. It will also be noticed that its direction and unusual length of insertion permit a close grinding of the tooth, which would cause the usual short and horizontal pin very soon to break away from the porcelain. The double-headed pin, a previous patented

FIG. 1022.

invention of Dr. White, was a very great improvement in the shape of tooth pins; but it has been superseded by this new "foot-shaped pin."

Fig. 1022 represents both plain and sectional gum teeth with the lateral or cross-pins, devised by Dr. C. H. Land, which, it is claimed, give greater strength to the completed denture than when teeth with the ordinary pins are used. For continuous-gum teeth a complete arch is formed by twisting or soldering the pins together, thus lessening the strain upon any single tooth, and allowing a much lighter plate to be used. What are styled "countersunk teeth" are also manufactured, in which the pins are attached to the teeth in a depression or cavity formed in the base of each tooth. (See Dr. Cryer's method of mounting, in chapter on Celluloid.)

The pins being properly adjusted, the enamels for the tooth and the gum are placed in the moulds by means of a small steel spatula, carefully placing them in the exact position and quantity required; the body is placed in them in lumps corresponding to the size of the teeth; the top of the mould is then put on and the matrix placed under a press, which compacts each separate mass. They are then dried by a slow heat. When perfectly dry the top is removed, and the teeth will now drop out. In this state they are extremely tender, owing to the large percentage of feldspar, and require very careful handling.

They are now sent to the trimmers' room, where each tooth is carefully inspected and all imperfections removed or filled up; the spare edges left by the union of the two sides of the mould are smoothly filed, and the arch of the gum over each tooth made rounding and true with a small pointed instrument. They are then placed on beds of coarse quartz sand, on trays or slides made of fire-clay, and are ready for the furnace. Formerly there was another process, called crucing, or biscuiting, which was universally practiced, and is still used in some factories; it is also used in the making of blocks carved to order. It consists in submitting the teeth after moulding to a heat sufficient to harden them so they can be cut or filed like chalk, and what is called an *outside enamel* is then applied with a camel's-hair brush; but it has been found that the composition of the tooth is injuriously affected by this partial burning, subsequent cooling, enameling, and reburning. This process is unavoidable when the blocks are carved by hand for special cases; but whenever they can be made in a matrix, the tooth is better and stronger when it is enameled in the mould and finished in a single firing.

The furnace is built substantially on the principle of the dentists' furnace (Fig. 943), differing chiefly in size. The trays holding the teeth are placed in the muffle, and are thus protected against injury from the gases of the fuel. There is no rule which can be given to determine the exact amount of time the teeth must remain in the furnace; the practiced eye of the burner must determine from the appearance of the teeth when the firing is completed. If taken out before they are done the enamel will craze, or crack, in cooling; if a little too much done, the surface will be too glassy and the body will not be strong. When cool the teeth are removed from the slides, placed upon wax cards, and are then ready for the dentist.

The vast variety in shape, size, color, etc., of the teeth thus made gives opportunity for the selection of forms suitable to nearly every

case which presents itself to the practitioner. The assortment must of necessity be very large and varied to meet the wants of the operator; in fact, the manufacturer has shown a better appreciation of the æsthetic requirements of the dental art than the practitioner. While the work of the latter too often exhibits an unmeaning monotony, the former has made provision for even the extreme cases which are sometimes met with; he has also given a beautiful series of those various deviations from a uniform regularity which are so common in natural dentures. In some mouths these seem to be imperatively demanded to restore the familiar expression, while in any mouth the use of some one or other of them would go far to disarm that suspicion of artificiality detection of which is mortifying to most patients.

Porcelain is a material in which the beauty of the result well repays the highest exercise of Art. It has been for centuries a favorite material for expressing the Poetry of Form. The famous Etruscan vases of antiquity, the exquisite gems of the *Majolica* of the sixteenth century, the marvelous work of Bernard Palissy, the prince of potters, the beautiful productions of the Sèvres and Dresden manufactories, the well-known charming designs of the Wedgewood ware, and the still more recent Parian statuettes, may be named in proof of the fitness of porcelain to embody the conceptions of Genius. Dental porcelain is worthy of such associations; not only like them does it delight the eye and give evidence of high æsthetic cultivation, but it adds to beauty the charm of usefulness. It is customary to attribute the rapid growth of Dental Art, since 1840, to its associations, colleges, journals, and its didactic literature—and with much truth. But to porcelain it owes its very existence as an æsthetic art, and the larger part of its extent and utility as a prosthetic art. It was altogether impossible for perishable human teeth, or their wretched imitations in ivory, to offer such tempting fac-similes of nature as we meet in porcelain. By thus creating that enormously increased demand for dental service which has been the chief cause of the rapid development of its resources, it has made the dental profession its debtor to a greater extent than any other single influence. The depot not only renders service by the superior excellence of the surgical instruments and prosthetic materials which it supplies, but it directly benefits the science and art of dentistry by releasing the practitioner from manufacturing toil, and giving time for the acquirement of increased knowledge and skill. Thus, if the time heretofore given to block-making were devoted to the study of dental æsthetics, patients would have the benefit of an artistic selection from a far larger

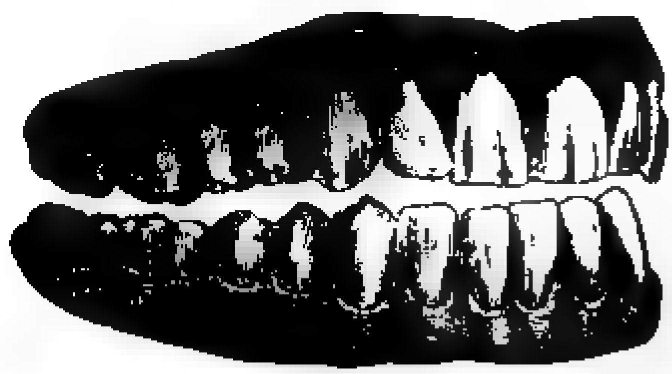
variety of porcelain dentures than could otherwise be possibly made. The illustrations of this chapter can but imperfectly convey an idea of the beauty and expression of the originals; they will, however, assist the student in his study of those principles which guide in the selection and arrangement of teeth; they may serve also to awaken practitioners to the extent of the present resources of Ceramic dentistry, and to the importance of æsthetic culture in order properly to make full use of the same.

The improvements in the Dento-ceramic Art have sprung from a careful inquiry into the essential characteristics which artistically formed porcelain teeth should possess. Among these are (1) *Naturalness;* under which term are included shape, color, and a vital appearance, the last depending upon the precise amount of translucency, the texture of the surface, and the nice blending of the colors of the body and enamel—an appearance which should be maintained as well under artificial as under solar light. Many teeth which will bear inspection reasonably well in daylight have a very unnatural and artificial appearance when exposed in the mouth to a light under which the wearer may be most anxious to excite admiration. (2) *Shape;* which includes a preservation of the distinctive characteristics of each tooth, securing the instant recognition of its position in the dental arch. There must be some defect or inaccuracy of form if, out of the twenty-eight teeth of a set, in unassorted confusion, an experienced eye cannot tell the place of each; for every tooth has its distinctive contour. Not only should each tooth possess the individuality which belongs to it, but it should also indicate the character of its relation to its companions on either side and to its antagonist. The eye trained to observe nature should not be offended by the recognition of any inharmony; should not find a second bicuspid or molar in place of a first, or incisors undistinguishable from each other, or an upper tooth in place of its corresponding lower one; nor should it detect in the midst of one style of denture some incisor or canine characteristic of another. Figs. 1023 and 1024 exhibit very strikingly the marked peculiarities of each one of the twenty-eight teeth of an artistically designed artificial set; while these and subsequent illustrations demonstrate how possible it is for modern dentistry to adapt its work to the great varieties of facial expression. Probably every reader has more than once turned at the sound of a familiar voice, to see a face strangely resembling the looked for friend. This correspondence between voice and face, often so startling, is only another one of those links between external and internal confor-

mation, which makes the study of æsthetic anatomy essential to the success of the dental mechanician.

The great law of correspondence, which enabled Cuvier to build up the entire skeleton from a single bone, makes us associate the

FIG. 1023.



idea of intellect with certain forms of forehead, and of character with certain forms of mouth, nose, and chin; it is the same law which

FIG. 1024

permits us to infer from what remains the expression of what is lost. Age, sex, temperament, and complexion, also many physical, mental,

and even moral peculiarities, are suggested to the acute observer by certain characteristics of the dental organs. The artist who seeks to restore harmony in the facial expression should be skilled in the observance of these varied manifestations; such skill is demanded alike in the manufacture and in the application of artificial dentures.

In addition to these æsthetic qualities porcelain teeth should possess (3) *Strength* adequate to the legitimate use for which they are intended; this strength should come from the quality of their composition, the skillful distribution of bulk to parts most requiring it, and from the due form, position, and proportion of the pins, rather

FIG. 1025.

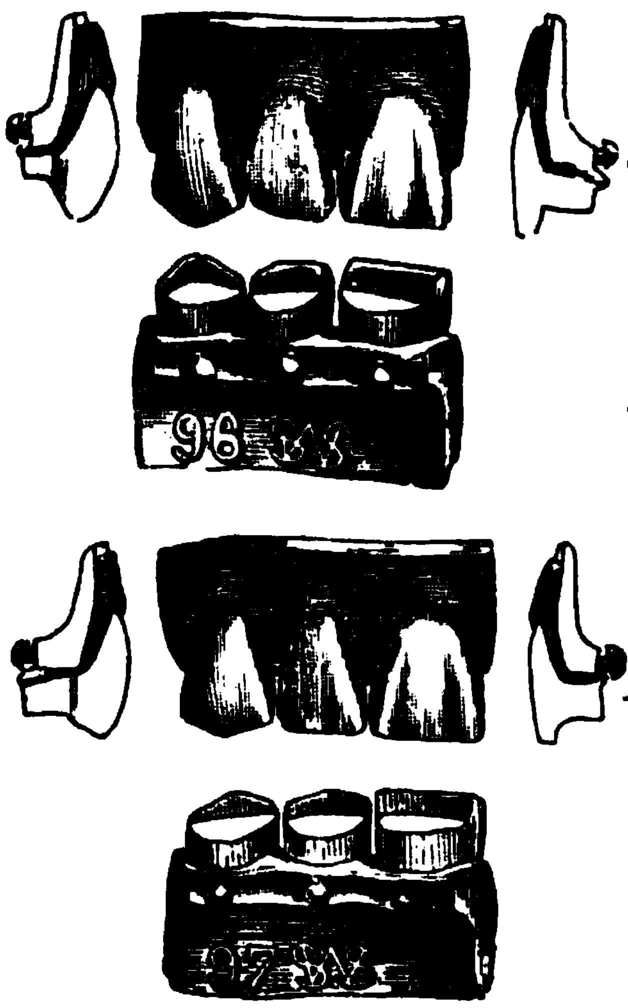
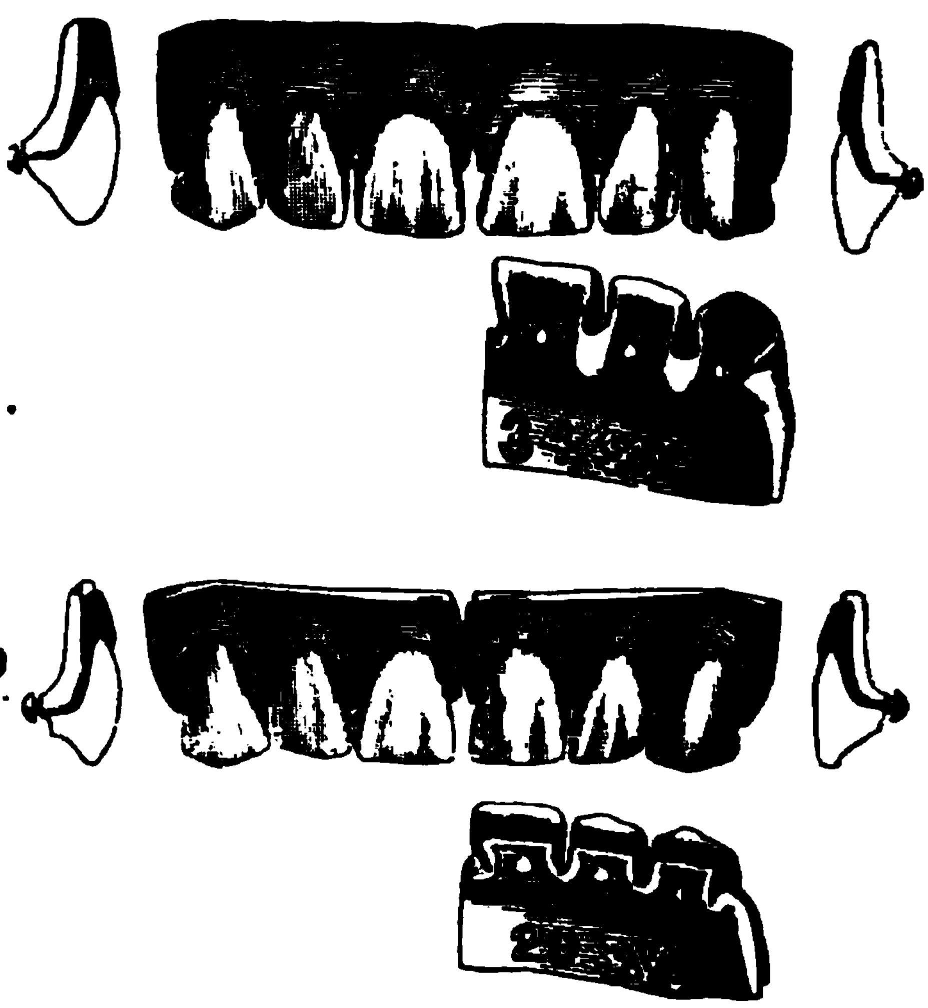


FIG. 1026.

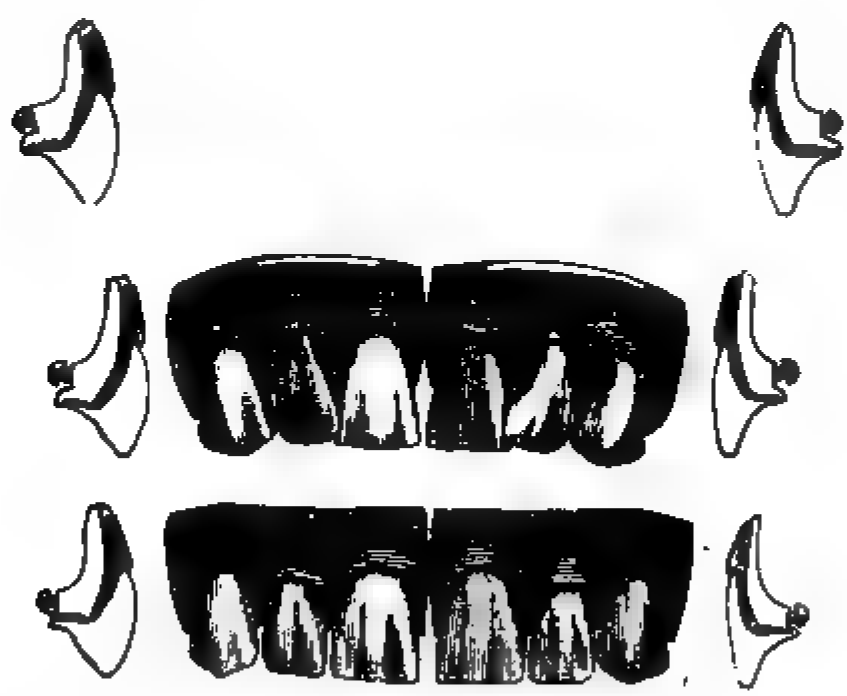


than from any increase in bulk and weight beyond that of the natural organs. They should possess, also, by reason of their conformation (4) *Adaptability* to the various irregularities caused by unequal absorption of the alveolar ridge, so that when judiciously selected they shall require little labor to adapt and antagonize them. Special provision should be made for the results of extreme or very irregular absorption, or for the loss, by disease or otherwise, of parts of the maxillary ridge, so that in such cases the teeth can readily be made to articulate and afford comfort to the wearer, assisting in speech and mastication, and yet not presenting any incongruous appearance.

There are, moreover, special modifications demanded by many other conditions; as, for instance, in cases having a very short ar-

ticulation, requiring the pins to be set in a recess near the crowns of the teeth and also in countersunk depressions under the base of each tooth, thus bringing the greatest resistance where there is the greatest strain in mastication, as is well shown in Figs. 1026, 1048. In both these blocks the full external size of tooth is given, and its characteristic form and the expression of interdental gum preserved; this could not be done with the usual form of blocks, ground down to suit such cases. In Fig. 1025 we have front blocks for mouths where a shoulder is required to antagonize with the lower front teeth when there are no back teeth remaining. Where early contraction and protrusion of the upper maxillary arch has caused it to have a sharply curved projection, bringing the closure of the lower teeth much behind the upper ridge at the central inci-

FIG. 1027.

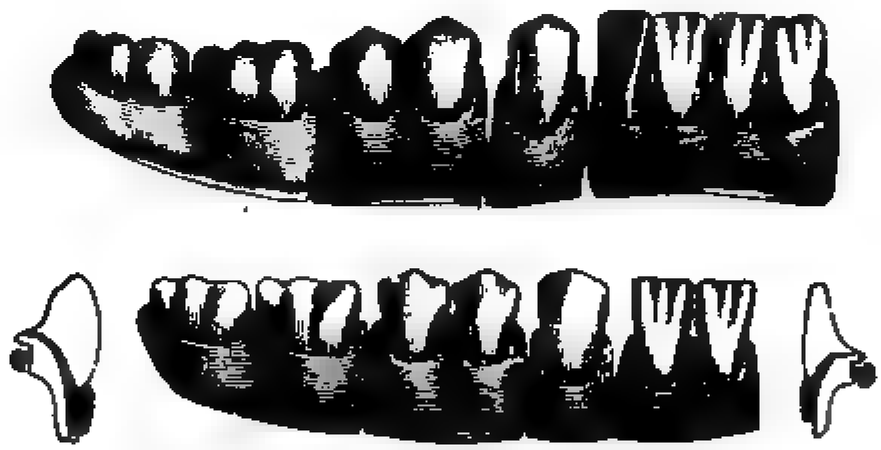


sors, or where absorption above has left a ridge prominent at its lower edge or margin of the gum, it becomes necessary to give a peculiar twisted form to the front blocks. In Fig. 1027 the first two blocks are for a pointed arch, accompanied in the second by a crowded denture, so often seen in such cases. It is impossible to adapt blocks of ordinary form to such cases without destroying their true expression at one or other of the joints; in fact, much of both gum and tooth is often sacrificed to get correct articulation. The third blocks are shaded with a view to show the fullness of gum at the centrals and its falling back over the canines; this is also shown in the sectional views of the first and third blocks.

For cases in which the lower jaw closes more or less in advance of the upper maxillary ridge, a large gum is often necessary, as in

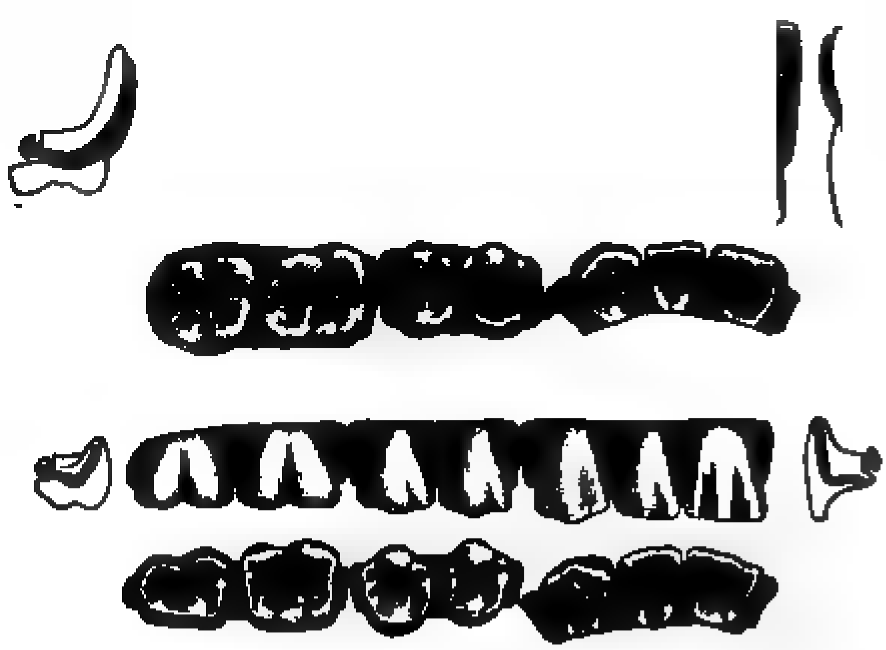
Fig. 1029; but such mouths require a peculiar form of block if the lower jaw has much projection. Where such a prominence of the gum exists, from want of exterior absorption or the previous wearing of a plate, as to require the teeth to be set directly upon the ridge there should be no artificial gum between it and the lip. When the molar block of lower sets extends to where the ramus of

FIG. 1028.



the jaw begins to rise, a peculiar plowshare curve of the base is required; such that, while the gum of the second bicuspid lies on the outside of the ridge, the gum of the second molar may lie partly upon the ridge, so as to give more perfect antagonism with the

FIG. 1029.



upper molars. The molar and bicuspid teeth from which Fig. 1028 was drawn are also marked by a characteristic curve of the buccal surfaces, giving not only a very natural appearance, but acting as a guard to the cheek and preventing its being caught between the teeth.

Fig. 1029 illustrates the difference of shape required for a mouth

where front absorption permits the artificial gum to overlap the alveolus, and one where fullness of the natural gum requires the block to set directly upon it. In the latter case, if the color of gum is judiciously chosen and the blocks well adapted, the triangles of artificial gum will be scarcely, if at all, distinguishable from the natural; we regard this as an extremely useful form of block. Sectional view of the molar in the upper cut shows the curve necessary to bring its grinding surface directly under the ridge; the views of grinding and cutting surfaces, together with front views, show how each tooth has a distinctive character; as, for instance, in the bicuspids, so often chosen without regard to the difference in form between the first and second. Again, the curve of the front block shows two of several variations required in the curvature of the arch; in the upper, the sharp turn at the canine gives a squareness across the incisors; in the lower, this turn is at the central and is adapted to a pointed arch. Variations in curvature of the

FIG. 1030.

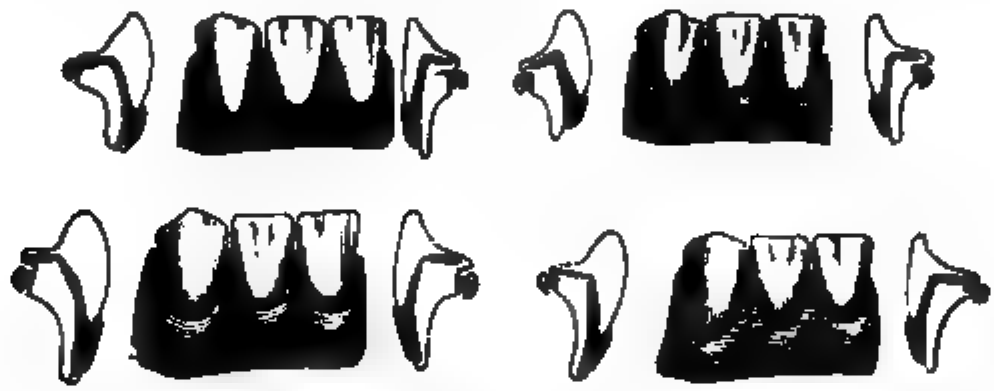
arch are also shown in Figs. 1024, 1037. Notice also the marked difference in the character of the bicuspids and molars in upper and lower cuts and the totally different expression of the front teeth.

Fig. 1030 shows how the same intermaxillary space may be filled with teeth of a widely different size as well as character. In the first, a very long tooth and short gum; in the second, a very long gum and short tooth. But length of teeth is by no means the only difference here; relative size of central and lateral, direction of the axis of lateral and canine, and outline of cutting edge of the block, are three features which equally mark the distinctness of these two styles; these also are points which demand that both long and short teeth shall differ among themselves as widely as these samples differ from each other. The lateral view of these teeth shows another marked difference in form.

Fig. 1031 gives the characteristic equality of lower incisors, or slightly greater size of the lateral; it also gives some of the diversities in length, width, shape of cutting edge, and form at arch of the gum. Although there is much less difference in the shape of the

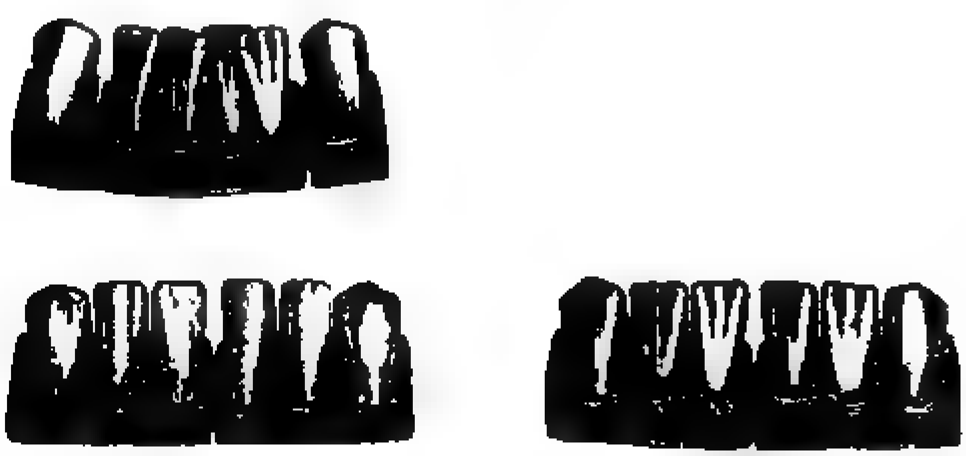
six lower front teeth than of the six upper, it is a great mistake to suppose that a given lower block will answer for any lower case if only long enough. Side views show also a difference in the slant of the teeth, inward or outward, which has an important effect in modifying the expression of the lower arch. There are also differences in curvature of the lower arch as well as of the upper. Fig. 1024 shows the usual upper and lower curves, and Figs. 1029 and 1037

FIG. 1031.



show variations of upper curvature requiring some modifications of the lower, dependent on the character of the articulation. In Fig. 1032 are four other forms of lower front blocks, the value of which will be at once recognized. The two right-hand sets differ from those of Fig. 1031 mainly in the length and width of teeth.

FIG. 1032.

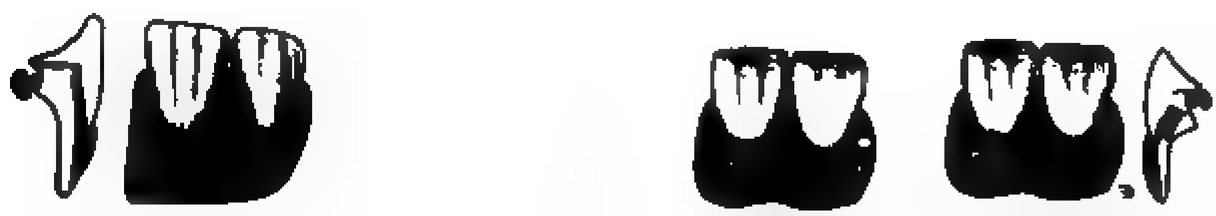


The left lower set is well suited to patients whose natural teeth, for many years before their loss, were marked by exposure of the neck; this appearance may also be increased (sometimes it may be made) by judicious use of the corundum wheel, but the block here given is invaluable for such cases. The left upper block is an admirable imitation of a very usual arrangement of incisors, resulting from crowded dentition; the drawing gives a very imperfect idea of the great beauty of the original porcelain block. When the facial ex-

pression indicates its use, it will have great effect in disarming suspicion of artificiality—a very desirable quality in artificial dentures.

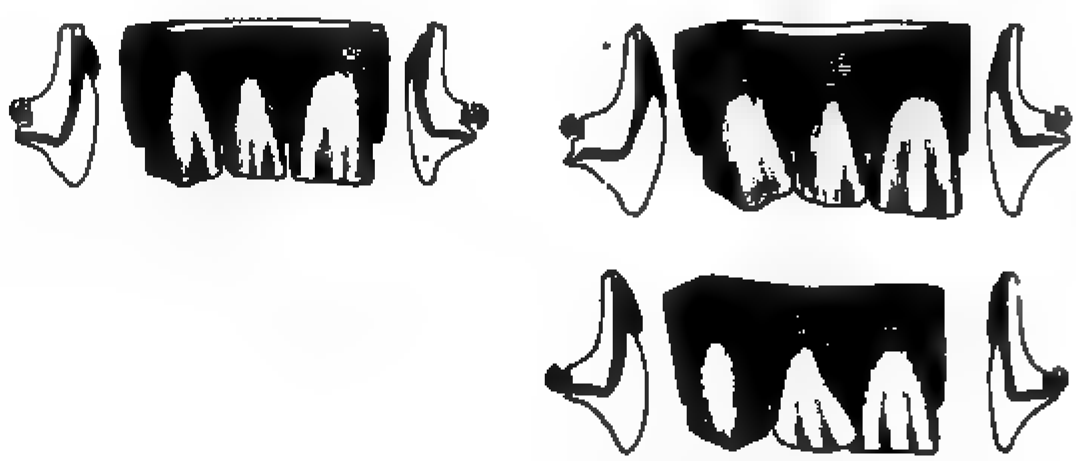
In Fig. 1033 we have very convenient modifications to suit front spaces of two or four teeth, the set of four being in two blocks.

Fig. 1033.



The peculiarity of these blocks is the lateral finish of the gum; instead of a square joint, for fitting to an adjoining block, they have a rounded edge of gum color that can be adapted to the curves

Fig. 1034.



of the absorbed natural gum. There should also be blocks of two, a lateral and central, with gum shaped like the double central, as such spaces are of frequent occurrence. Besides the four forms of

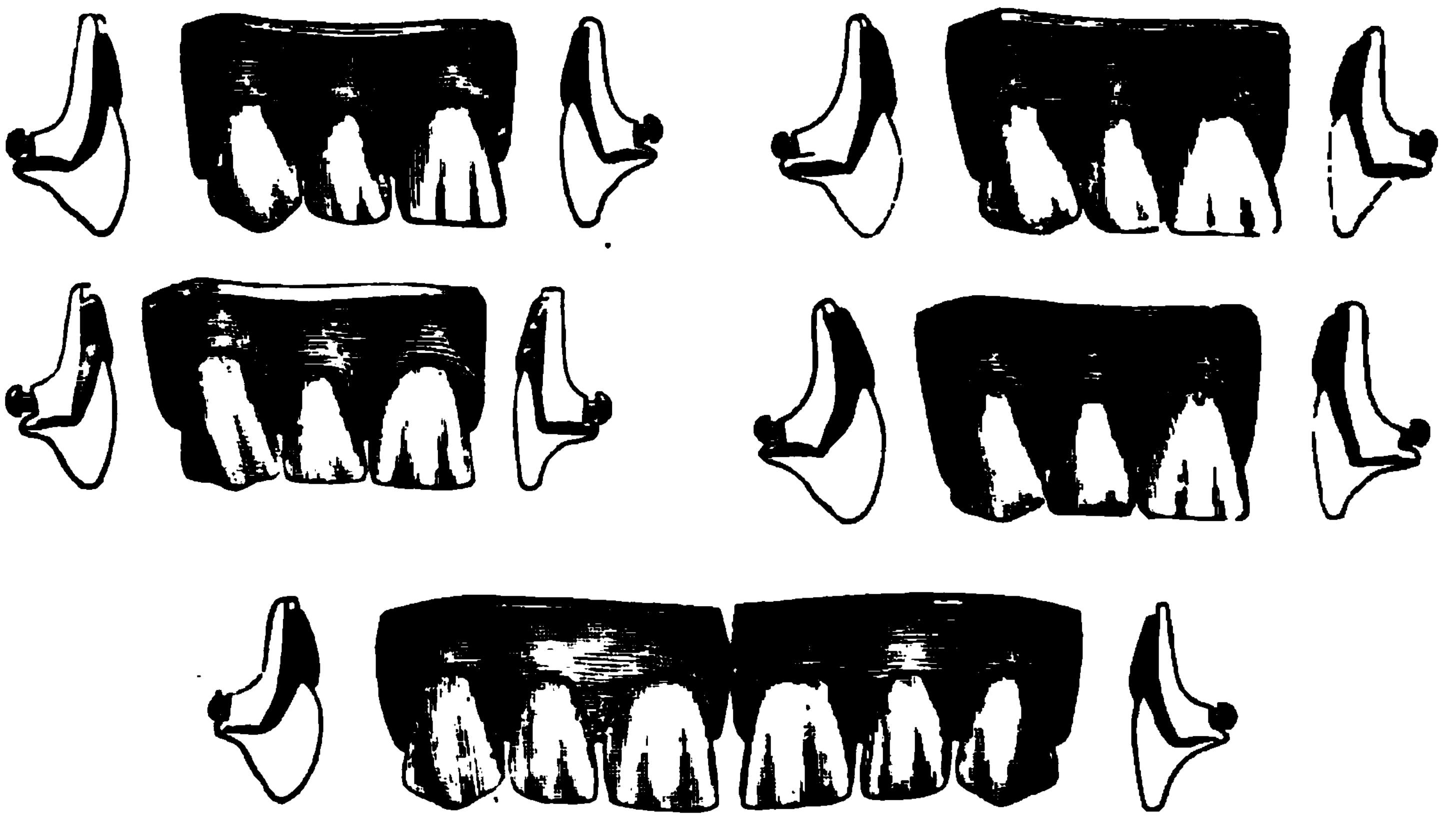
Fig. 1035.

teeth here given there are many other varieties in size and shape of this very useful kind of block.

Figs. 1034, 1035, and 1036 represent a few of the great variety of

forms of upper incisors and canines designed to meet the demands of an æsthetic discrimination. In Fig. 1034 we have, first, a long, delicate lateral, with sloping but not rounded edge, showing a decided space between it and the cuspid and central; then we find it wider, with corners and edge rounded and filling the space. Lastly, for want of space, the laterals, although long and narrow, overlap the centrals; this style is generally accompanied with a pointed arch. The fourth block, although with an overlapping incisor, has an entirely different character; it is often found in a rather flattened arch and does not indicate a crowded denture. In these blocks

FIG. 1036.



the inclination and shape of the canine as well as the shape of the incisor help to give to each block a distinctness of character which will not permit the use of one in a case demanding either of the others.

The *celare artem* effect of overlapping or twisting laterals, like that of irregular lower incisors, is such as to tempt one to use them whenever admissible. In Fig. 1035 we have some additional varieties of this kind of block. In all these six cases we find differences in the size and character of the lateral, in the extent of its lapping, and in the degree of twist given to it. A careful study of the natural teeth will teach the dentist what character of face is best suited to each of these different forms, and thus he will much increase the extent to which he may properly use this kind of irregularity.

In Fig. 1036 the blocks vary little in size, yet they each have a distinctive character. In the first we have lateral rounded on both corners and its axis vertical; canine, with pointed cusps and edges quite rounded. In the second we have lateral inclined, with me-

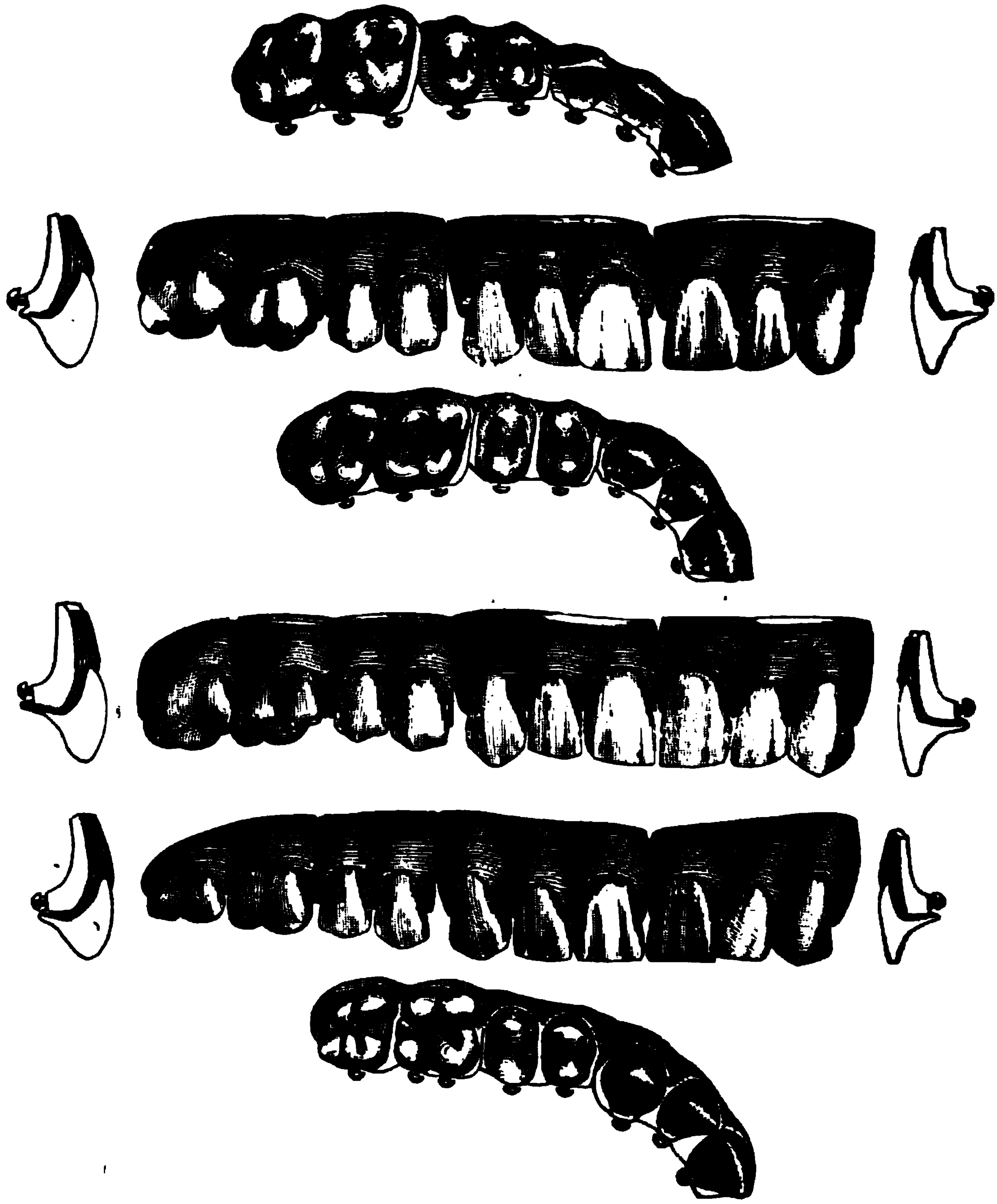
dian corner pointed, lateral corner quite round; canine with blunt cusp, also axis inclined. In the third, surface of the canine is decidedly furrowed, which, with the indented edge, gives it a marked character; the lateral and central, unlike the previous blocks, have square-cut edges with corners but slightly rounded. In the fourth, the lateral is more nearly equal to the central, and none of the teeth may have any marked peculiarities; this style of block, in its different sizes, suits well in many cases, and is perhaps one of the best for general use by those practitioners who pay no regard, in their selection of teeth, to the indications given by the physical characteristics of the face and head. The fifth block is one of that class often met with in old age, where, by the action of the lower teeth or other causes, the arch has spread, widening the interdental spaces. The interdental gum is also much shorter than in youth, as is finely shown in the original from which this cut is taken.

In the selection of porcelain blocks not only must the color, size, and form of the teeth be carefully considered, but reference must also be had to the curvature of the arch. For although moderate variations in curvature can be fitted by the same set of blocks, the true expression of a porcelain denture is often lost by the attempt to adapt it to a curve for which it was not designed. In Figs. 1024, 1029, and 1037 we have various curves of the alveolar arch, with corresponding variations in shape of the blocks. Sometimes the canines are made separate with a view to increase the range of application of a given set; but a joint on either side is very apt to injure the effect of this important tooth. In the lower jaw it is of less consequence because the gum is less often exposed, and it is frequently desirable to make the four incisors in one block. But in the upper jaw it is much better to have a median joint and another behind the canines.

In Fig. 1037 the reader will notice that the centrals of the first set overlap the laterals, an arrangement of frequent occurrence in prominent and sharply curved arches. It will be observed that in Fig. 1027 the blocks are so shaped that the right or left central overlaps its fellow. Thus we have three varieties of overlapping upper teeth—laterals over centrals, centrals over laterals, central over central—each of which may be used with great effect if applied with discrimination. In the third set of Fig. 1037, and in a few of the preceding cuts, the gum over the cuspids is very strongly marked. This is a very characteristic feature of some mouths, and when correctly used gives a fine effect; but it would sadly belie the expression in a timid and gentle lady's face. Yet such incongruity is only one of hundreds constantly occurring, where every sense of

æsthetic beauty and harmony is violated—teeth of a Russian in the mouth of a Frenchman, those of a New Englander given to a South Carolinian, or those of a Canadian to a Cuban, the lips of age disclosing the teeth of youth, and no distinction made between

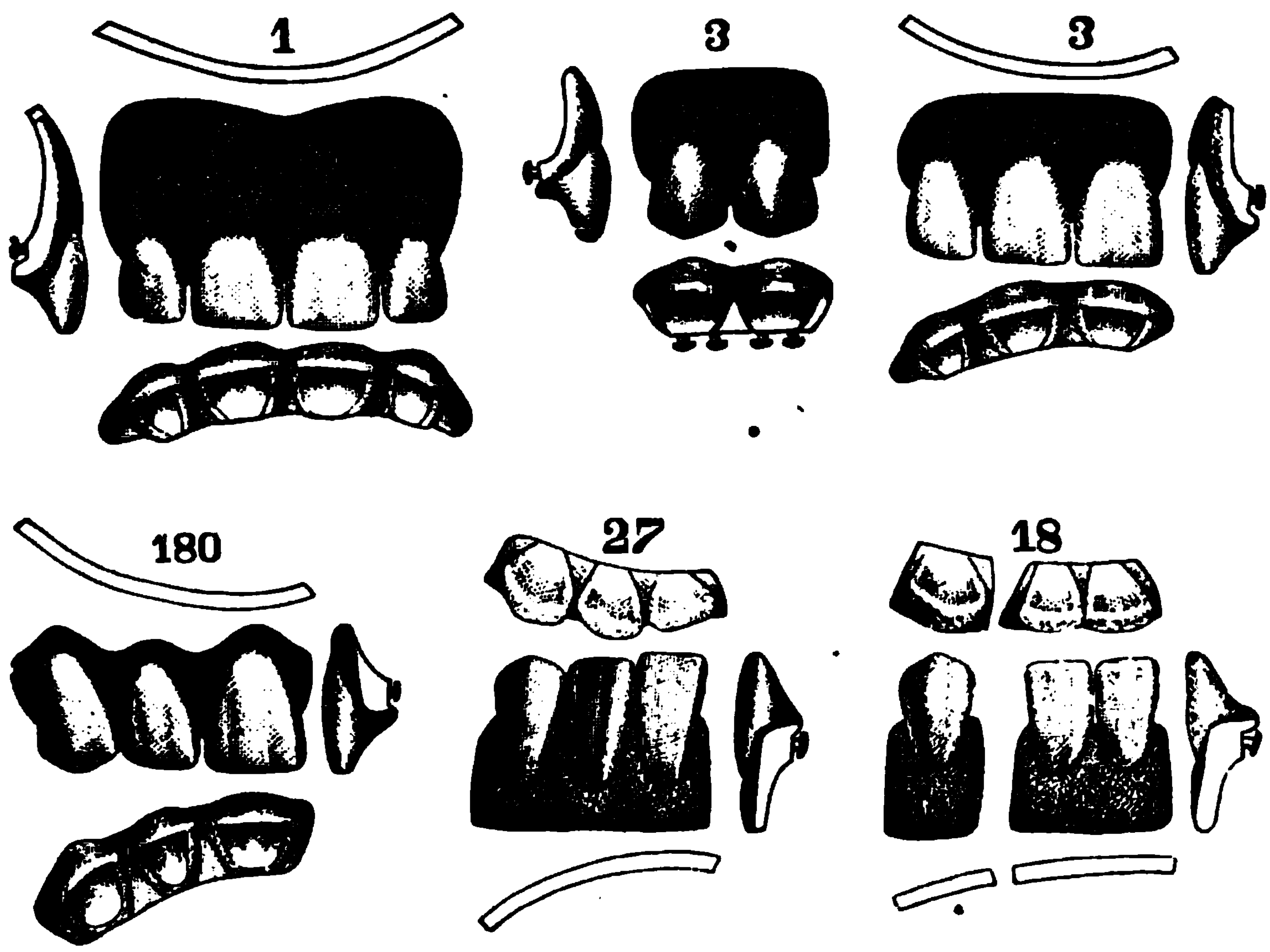
FIG. 1037.



a male and female denture. These æsthetic blunders are not confined to the inexperienced tyro, but are perpetrated by many who presume to call themselves skillful mechanicians. When we consider the extensive assortment of porcelain teeth which ceramic art has placed at the disposal of the practitioner, such malpractice is without excuse.

These are only a few out of the great number of varieties, in size, form, and arrangement, of porcelain teeth; they give to the dentist a much wider range of selection than some have the ability or in-

FIG. 1038.



clination to avail themselves of. When to variety of shape we add shades of color, the number of sets that admit of being made, distinguishable at a glance from each other, seems almost infinite. A

FIG. 1039.

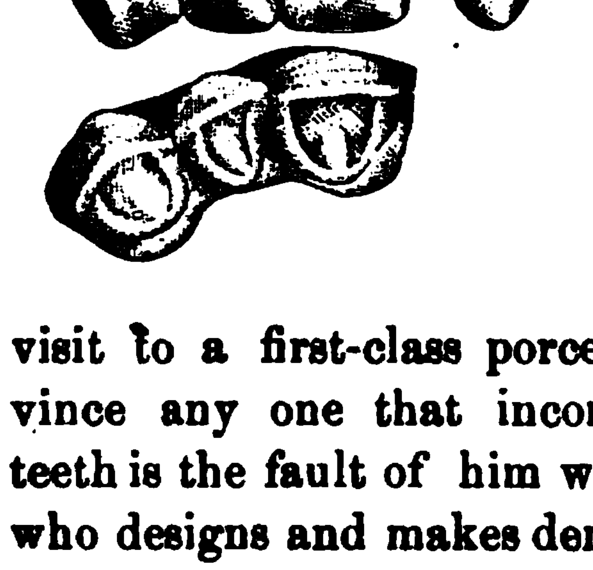


FIG. 1040.

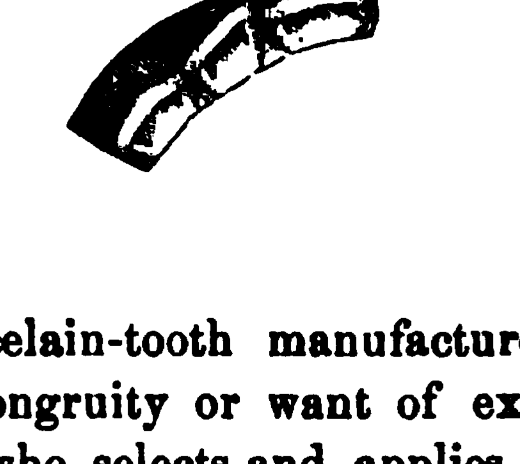
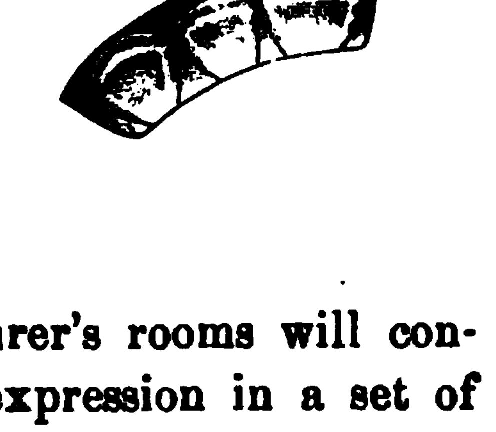


FIG. 1041.



visit to a first-class porcelain-tooth manufacturer's rooms will convince any one that incongruity or want of expression in a set of teeth is the fault of him who selects and applies, rather than of him who designs and makes dental porcelain.

Fig. 1038 represents upper and lower gum sections of four, three, and two teeth, one of the upper sections having partial gums.

Fig. 1039 represents an irregular gum section with the lateral out of line.

FIG. 1042.

FIG. 1043.

FIG. 1044.

Fig. 1040 represents a gum section with an extra long central incisor.

Fig. 1041 represents a thin gum section.

Fig. 1042 represents gum sections for protruding upper and lower jaws.

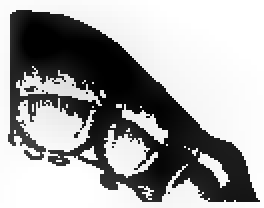
Fig. 1043 represents a shouldered gum section.

Fig. 1044 represents a festooned gum section.

Fig. 1045 represents a gum section for a V-shaped protruding upper jaw; the position of the lower teeth is shown by the dotted lines.

It will be perceived that the foregoing illustrations* of the æsthetic principles of the dento-ceramic art are taken from one class of teeth, those for vulcanite or metallo-plastic work. We have done

FIG. 1045.



so because the art has here had its fullest recent development in consequence of the great demand for this form of block. But dental æsthetics is quite independent of the material of the plate, so long as that which is visible in the mouth is porcelain; and dentures which show any substitute for the gum other than this, however useful they may be, cannot rank as specimens of highest art until some material for the plate shall be discovered possessing higher claims to beauty than any yet known.

* We are indebted to the kindness of the late Dr. Samuel S. White, and more recently of the S. S. White Dental Manufacturing Company, of Philadelphia, for the admirable illustrations by the aid of which we have been enabled to express our views upon the important subject of dental Æsthetics. No illustrations, however, can convey a true idea of the high artistic excellence of those forms the production of which has placed Dr. White among the greatest benefactors of Dental Art. We take this occasion to acknowledge, also, the liberality and courtesy with which our inquiries for information on the manufacture of dental porcelain were responded to by this gentleman.

The foregoing rules will apply to the form and size of plate teeth when these are set directly upon the natural gum; but, except in case of true pivot or plate-pivot teeth, it is impossible to reproduce the precise natural arching of the gum above the tooth without some gum-colored porcelain. We must often be content in such cases with the nearest possible approach to nature. But when the plate is seen on the outside of the arch, the artist's reputation is dependent upon the concealment of the greater part of his work; even here, however, the cutting edge and two-thirds of the tooth permit the display of great varieties of expression. Of plain teeth without gum there are four kinds. 1. Pivot teeth; shaped somewhat like the crowns of the upper incisors and canines, with a hole in the base for insertion of a wooden or metallic pivot. 2. Plate teeth; the oldest known form of porcelain teeth having pins for attachment of a back by which to secure it to the plate. 3. Continuous-gum teeth; resembling natural teeth in having a root, which is more or less serrated, for better retention in the investing porcelain base; they are sometimes made without platina pins; but they are better with pins, so that they may be securely fastened to the platina plate. 4. Plain vulcanite (Fig. 1053); having a small neck, by which they are held in the vulcanite or other material in which they are set. These teeth may be set directly on the gum by grinding off the neck; they may also be used adjacent to natural teeth with exposed neck, by slight alterations of this neck, so as to give to the artificial tooth the same appearance as the natural one.

There are also other forms of gum teeth besides those above represented. Formerly, single gum teeth were extensively used on gold plate, and may still be occasionally required when the supremacy of that old-fashioned material becomes once more recognized in the laboratory. The great facility of adapting blocks or sections in vulcanite work or in vulcanite attachment to swaged plates has led to the almost entire exclusion of this form of tooth except for repairing. A serious objection to single gum teeth is the number of joints; these greatly mar the artistic effect which it is the design of the artificial gum to produce, especially when not kept perfectly clean or when the material of plastic plates is allowed to enter the joints. Figs. 1023 and 1046 are designed to show the importance of correct and accurate grinding in order to display the true character of a set of teeth. When properly done, the joint does not interrupt the continuous surface of the gum more than the lines in the two lower sets of Fig. 1046; nor should it in any case be more visible than the heavier lines of the first set. Neither should the set be so inaptly chosen as to require such grinding of joints and base as to

injure its original expression. Figs. 1023 and 1046 should also be carefully studied by the student on account of the varieties of form and relation of teeth presented, each of the four upper sets here displayed having a very distinctly marked character.

Porcelain blocks which are to be attached to a gold plate by soldering do not differ in external appearance from the forms already illustrated ; but the shape of inner surface and the form of the pins are different. Fig. 1047 represents such a set of upper blocks in three sections. If made in four sections, the set should be divided between the centrals and between the bicuspids; it may

FIG. 1046.

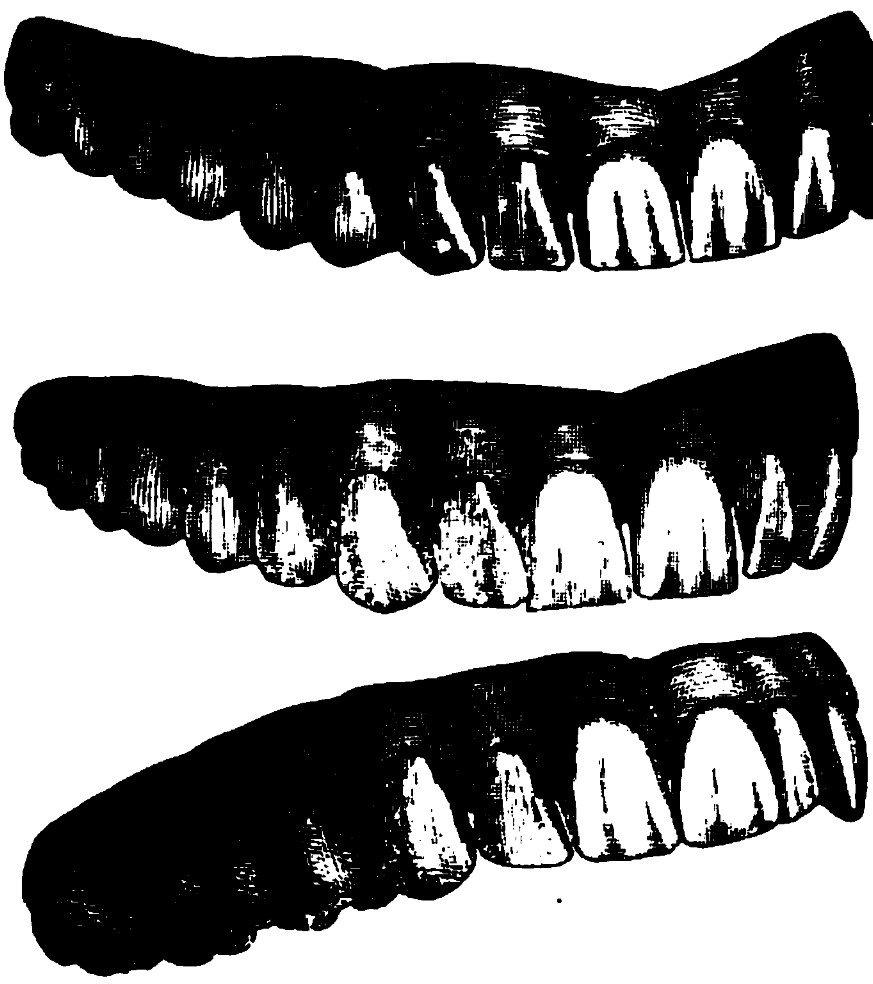
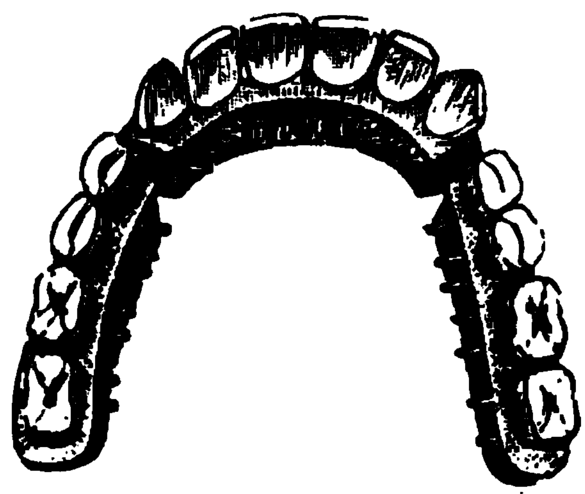


FIG. 1047.



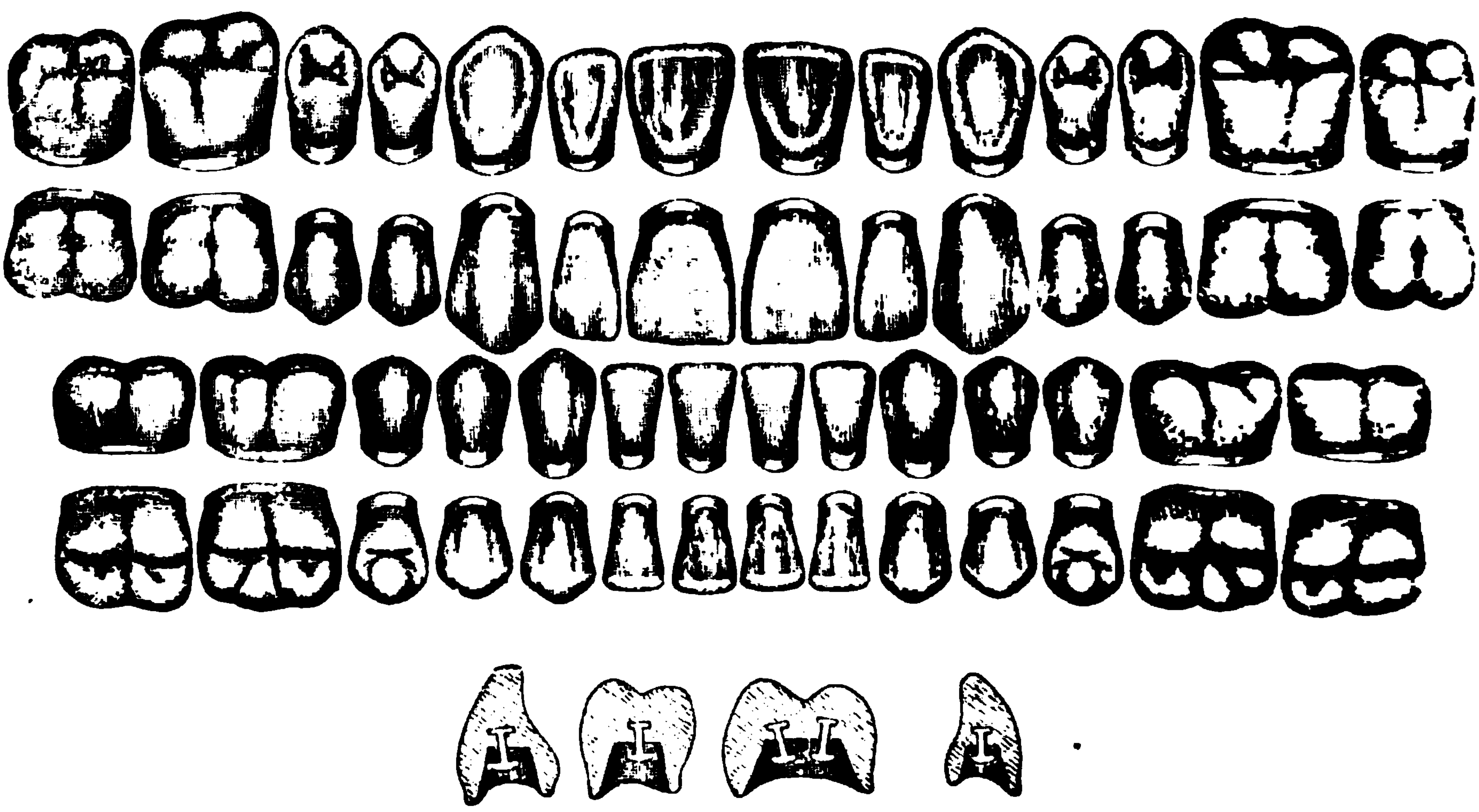
also be in five sections, the four joints being in front of the cuspids and behind the bicuspids; or it may be divided into six sections, as in Fig. 1023. The line above the pins in Fig. 1047 marks the division between the inner slope of gum next the teeth and the plain surface holding the pins; this surface should be as smooth as possible for the perfect adaptation of the gold backing. Blocks may also be made in sets of three or five sections, with the inner surface finished in gum enamel to the plate; in this case the block is held to the plate by pins passing into holes made in its base, one opposite each tooth. The best material for retaining the pins is undoubtedly vulcanite, as described in the previous chapter; the holes should be rough for its better adhesion.

Fig. 1048 represents the "Countersunk Tooth Crowns," which allow of great facility of adaptation to the maxillary ridge and (it is claimed) afford the strongest denture on a plastic base. To insure

the best results some precaution is necessary in mounting them, whether on rubber, celluloid, or metal.

For a vulcanite base the case should be flasked as usual, but each countersink should be carefully filled with small pieces of rubber; otherwise the flat rubber sheet will cover the mouths of the counter-

FIG. 1048.



sinks and so shut in the air as to prevent the rubber from reaching the pins and filling the cavities.

When the base is of celluloid the countersinks must be filled in like manner, with pieces of celluloid moistened with spirits of camphor, or

FIG. 1049.

preferably with a solution of celluloid, and the case heated to softness before closing the flask.

For a fusible metal base the hot flask should be jarred during the pouring to drive the air out of the countersinks.

Fig. 1049 represents perforated bicuspid blocks.

Fig. 1050 represents rubber bicuspid blocks with pins.

The dental depots cannot keep on hand an assortment of such blocks, since the demand is too limited to justify the expense of the brass moulds. But in all our principal cities there will be found one or more dental-block carvers, whose experience and constant practice enable them to make any style of blocks that may be desired for special cases. We have elsewhere given our reasons for thinking this a better plan than for the dentist himself to attempt occasional ceramic experiments. Let him prepare an accurate articulating model and adapt a tin-foil plate (to avoid the risk of sending the gold one); then select one or more teeth to guide the carver in the required color and character of the set. If any peculiar form or deviation from the normal arrangement is desired, this should be represented in wax; then pack carefully and send to the block carver. This plan is recommended to those who may desire,

FIG. 1050.

for some special case, a form of blocks not to be had at the depots. Necessarily such blocks are much more expensive than those made by the quantity in brass moulds; but if the dentist values his time, the blocks would cost still more if made by himself.

The true question is, however, not one of cost; if the depot can furnish the form of blocks which the case requires, it is best to get them there, otherwise they must be had elsewhere and at any cost. Dental tradesmen, who sell their wares at a moderate advance on the cost of production, may not deem it prudent to deal in such high-priced materials; but the professional dentist, who charges for "services rendered," will never find it necessary to hesitate incurring *any* expense requisite for the perfection of his work. The actual cost of material in single dentures has often exceeded thirty dollars; yet the mechanician who exercises a skill commensurate with this cost never has found, and never will find, difficulty in adding a just compensation for his time and skill. As a rule, patients will pay best for art when exercised on expensive material, except where, as in painting, the effect produced is wholly irrespective of the cost

of the means employed. The true basis of professional fees lies in that which makes one man's work superior to another's; namely, artistic skill exercised upon materials, the quality of which shall not detract from its just appreciation.

As we have briefly described the processes of manufacture of porcelain dentures on a large scale—a work which, of course, no practicing dentist proposes to engage in—it is proper that we should also give a brief description of the processes by which blocks are carved for special cases, although we regard this as equally out of the line of the modern dentist's duties. We occasionally find a genius whose gift shows that ceramic art, not dentistry, is his true profession; but men engaged in ordinary dental practice must, in justice to their patients, make use of the experience of professional block carvers, or they must use those forms offered by the ceramic manufacturer, which are the results of the highest artistic skill which money can command.

SPECIAL BLOCK CARVING.

To make a porcelain dental arch in three sections for a full upper case antagonizing with natural teeth below, make a plaster articulator, as described in the tenth chapter, but having greater thickness to permit guiding holes or grooves, as in Fig. 1051. Open the articulator, increasing the space one-fifth (unless this one-fifth enlargement is to be made by addition of point enamel); place on the plate a wax rim, and trim it to antagonize with the lower teeth, giving the precise external fullness required in the blocks. Mark on wax and front edge of articulator the medial line and the lines of proposed division of blocks; that is, between bicuspids for a four-block piece and behind cuspids for a piece of three blocks; in either case the work is carved in three pieces. It is also well to mark, in fainter lines, the width of each tooth as determined by the size of the lower teeth; this will be some guide in the subsequent enlargement required on account of shrinkage of the porcelain paste. Next make a plaster rim about half an inch thick (Fig. 902, on page 970, shows the height and thickness), covering the exterior surface of model and wax, making first the front section, extending a half tooth space behind the lines marked for the block joints; then remove this and make the two side sections, extending each a half tooth space in front of these lines. The use of a leaden band and some paper pulp will expedite the making of these plaster sections; they should be trimmed to the exact length required for the crude blocks. Of course, neither in plaster nor porcelain can the front and side sections be applied to the model or plate at the same time, in consequence of the one-fifth allowance for thickness.

On removing the wax, each plaster section is a matrix to determine the external fullness of the corresponding block, on which is to be carved the shape of teeth and gum. The plate gives exact form to the base of the block; but when finished it will require grinding, because of the derangement of fit caused by shrinkage. The thickness and interior form of the sections is determined by the eye, and will vary with the style of finish or mode of attachment, being careful, in this direction also, to make the one-fifth allowance for shrinkage. The front block is first made and removed, then each side block separately; in a double set, both front blocks are made, then both right sections together and left sections together, so as to

FIG. 1051.

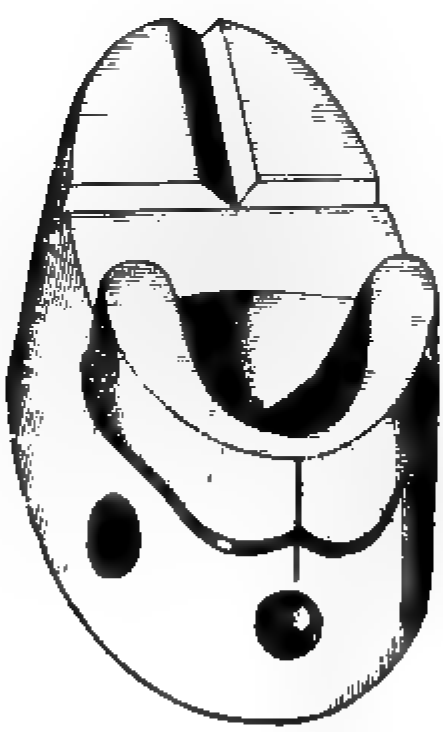


FIG. 1052.

obtain their proper antagonism; also, in double sets, the separation of the articulation must be sufficient to allow the one-fifth enlargement in each set.

The porcelain body is prepared as already explained; it can be compounded by the dentist or purchased from the manufacturer. In mixing the small quantities required for single cases, two points demand special care—purity of the water and absolute exclusion of air from the mass. It must also be remembered that irregular contraction, or warping of blocks in firing, is often caused by unequal compression in packing the body into the moulds and by unequal

absorption of its moisture by the porous plaster rim or other means used to dry it. Again, it should be remembered that in removing the rim, in carving, and in all other operations on the crude paste the excess of feldspar gives it a tenderness very different from the tough plasticity of a kaolin mass. The putty-like body is to be carefully worked into the well-oiled mould, compressed with the fingers, trimmed into outline shape, and then removed, first marking upon it the lines of the articulator to guide in the carving. The block may be partly or entirely carved while on the articulator; but the delicate movements of the very delicately-shaped carving tools are, in the opinion of some, best exercised upon the free block.

For carving no directions can be given beyond what has heretofore been said on the necessity of a close observance and exact copying of nature. The artist requires no written directions, and paper instructions never yet made an artist out of a bungler; in fact, the heaven-born genius of art cannot be created by teaching, however it may be trained and directed. Many have wasted years in porcelain block carving only to produce results surpassed by the least artistic forms offered in the depots; while, on the other hand, some dental Palissy will work out a marvel of beauty that no purchased blocks can equal. But before one imagines himself a Bernard Palissy let him read the history of that wonderful struggle of genius, then ask how far the routine duties of a dental office will permit an exclusiveness of devotion, which ceramic art rigorously exacts as a condition of success.

When carved, the blocks are thoroughly dried, then placed on coarse silex upon a fire-clay slab, and set into the muffle of the furnace (Fig. 1052). Here they are biscuited (or cruced), that is, raised to a red heat sufficient to give some hardness, but not to vitrify or even to cause incipient fusion. They are then slowly cooled and holes drilled for the pins, or else holes drilled into the base of the blocks, as may be preferred; the pins are fastened in place by a little "body-slip," carefully worked in with the knife point. Slight defects of carving may now be corrected; the enamels are then applied with a camel's-hair brush. They must be reduced to the consistence of cream, and require much skill and judgment in their application, so that the point enamel shall blend properly with the body enamel; also the gum enamel must preserve its distinctness of outline and, by its varying thickness, give those alternations of shade observable in the natural gum. It should here be remarked that some carvers make no allowance in the body for shrinkage in length of the tooth, but compensate by the addition of point enamel. The crowns of bicuspids and molars are usually enameled; also part of

the inner surface of the blocks, and in some blocks the gum enamel extends to the base. When platina pins are inserted, the part of the block to be covered by the backing is not enameled. It is scarcely necessary to remark that a large assortment of body, point, and gum enamels is required; also that these must, with great care, be kept separate, with their respective test pieces attached, for except by the pinkish color of gum enamel they cannot be distinguished when in form of powder, paste, or cream.

The blocks are now well dried and are ready for the furnace, Fig. 1052. (For other forms of furnaces see article on "Continuous Artificial Gum.") Success thus far is dependent upon: 1. Thorough mixing of the body and its careful packing; 2. Skillful carving, so as not only to give the required expression, but also to know what allowances to make at each point for shrinkage and for the subsequent application of the enamels; 3. Selection of enamels and their skillful blending and shaping; 4. The giving of such form, in adjustment of the relative length and thickness of each block and apportionment of material, as shall prevent warping in the furnace. These points, however, may have been perfectly attended to; yet all will have been done in vain, unless the operator has a thorough practical knowledge of the management of the furnace. It is this which makes the ceramic experiments of the practicing dentist so often a failure; for fail he certainly will unless he knows the exact heat at which the differing fusibilities of his body and various enamels will, by their combined effect, develop the properties aimed at in their combination. Some are governed in this by test pieces; the experienced workman, guided by constant practice in a way that he cannot explain, prefers the indications offered by looking at the piece itself. If not sufficiently baked, the body will be porous; also, neither this nor the enamels will have their true life-like character. If overdone, there is an offensive, glassy, and transparent condition, equally fatal to the natural appearance; also, there is too much shrinkage and greater danger of warping. Both errors impair the full strength of the porcelain, in which the ingredients are so combined as to develop greatest strength at a certain temperature.

Furnace temperature is measured by instruments called Pyrometers. The limit of mercurial registration of temperature is 600° Fahrenheit. Daniell's pyrometer registers by the expansion of a platina rod in a plumbago case and is the most accurate. Wedgwood's pyrometer registers by the rate of permanent contraction of kaolin under intense heat. A clay wedge fitting the upper part of a tapering groove will, after exposure to furnace heat, slip further

into the groove; supposing the rate of contraction uniform, this distance will be a measure of the heat after establishing its exact relation to the 600° point of Fahrenheit. But the contraction of any two pieces is not the same unless their composition is identical; also, the relation to the mercurial scale is not easy to determine. Wedgwood's zero was 1076° Fahrenheit, and he estimated one degree of his pyrometer equal to 130°; on which basis of calculation the highest heat of the porcelain furnace (130° *to* 160° Wedgwood) would range from 19,000° *to* 22,000° Fahrenheit). Others estimate his degree at 62.5° Fahrenheit, reducing the registration from 9500° *to* 11,000° Fahrenheit. Taking the fusion point of gold at 2000°, and of pure iron at 3000°, we thus have some idea of the infusibility of platinum and the extreme heat of ceramic furnaces. But it is evident that the correct regulation of this heat must be the result of experience rather than of written direction; also, that the furnace practice of different persons cannot be accurately compared.

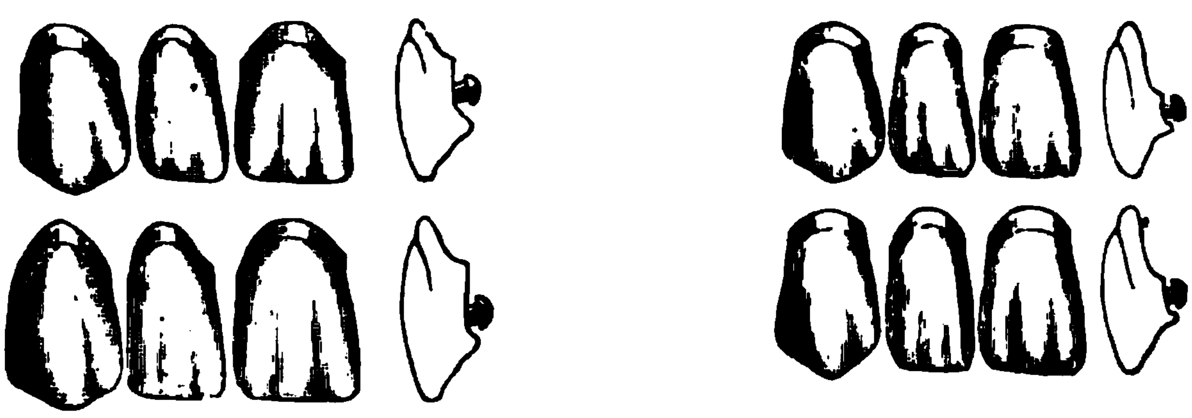
The muffle protects against the gases of the fire. Charcoal, coke, or anthracite are used as fuels, according to the location of the operator; the last is preferable when it can be procured, because it gives the steadiest heat; charcoal requires practice to maintain a uniform heat; coke is used in all the bituminous coal regions. With either of these, after sufficient experience, a furnace may be kept regularly at the required heat for a length of time sufficient to fire the porcelain blocks. They must be thoroughly dried on the furnace-shelf before going into the muffle; the mouth of the muffle should be well luted, and the stopper withdrawn only to examine the work. The more slowly blocks are cooled, the more perfectly are they annealed, and hence less liable to crack from sudden changes of temperature, as in soldering.

Not to interrupt the order of operations, we have deferred the description of a very ingenious method of carving devised by Dr. William Calvert. Instead of the wax rim before mentioned Dr. Calvert provided an assortment of teeth having all the varieties of form and size required in practice, but one-fifth larger than the given case. These are arranged in a wax gum and the plaster mould then taken. Thus, in Fig. 1053, teeth of the first size set in wax will give, when diminished by the furnace, teeth of the second size; so in Fig. 962, each of the two lower sizes in wax will give in the finished block the size above it. Dr. Calvert's method has three recommendations: 1. Like continuous-gum work, it limits the necessity of æsthetic skill (which so few possess in high degree) to the shaping of the gum, the judicious selection of teeth, and their

proper arrangement, leaving the details of form to the genius of the manufacturer's artist. 2. It permits the application of enamels, or rather the addition of body to enamels, without the necessity of crucing, which some regard as injurious to the tooth. 3. By selecting a variety of styles of model teeth, and by varying the relative adjustment of them in the wax, that tendency to uniformity of style is obviated which characterizes almost every block-carver's work.

Dr. Calvert's process differs mainly from the foregoing in the following details: For a four-block piece the teeth are set in wax shaped in exact imitation of the natural gum, omitting the second bicuspid, in place of which a half-tooth space is left between first bicuspid and molar, the wax gum being carried around continuously. The plaster mould of the eight front teeth is then taken, a

FIG. 1058.



thin septum of foil being placed opposite the mesial line, so that it may be easily broken there in the act of removal, the plaster coming slightly over the inside so as to give with certainty the shape of the cutting edges. Upon removing the front mould, and before making the lateral moulds, where as yet the wax holds only two molars, it is necessary to detach the bicuspid of the front block and put it adjacent to the molar; this gives the arch its full complement of bicuspids. This must be done very neatly, so as not to disturb the continuity of the wax gum, otherwise the effect of the porcelain blocks at their joints will be injured. Dr. Calvert prefers using cuspids for insertion in the wax instead of bicuspids, since their external expression is similar and their form more convenient, especially in the change just described. By similarity of form we do not mean that in any mouth the canines and bicuspids are alike externally; but out of a collection of canines, after choosing the cuspids themselves, others may be selected harmonizing with them as first and as second bicuspids. Besides overlapping the blocks at the bicuspids, to compensate shrinkage, a slight extension of each block beyond the last tooth should be made to allow for accurate grinding. If holes are made in the base, instead of platina pins in

the back, it will be best to make a continuous front block of six teeth, in which case the half-tooth space above named comes behind the cuspid.

Since the carved wax of the contained teeth makes carving of the porcelain paste unnecessary, the plaster moulds are varnished, oiled, and treated as are the brass moulds in wholesale manufacture. The stiff paste of point enamel is placed with a delicate spatula into each tooth matrix, thickest at the point and disappearing at the neck. The tooth enamel paste is then applied, with thickness reversed; gum enamel might also be added in the same way, but it is usually applied afterward with the brush, as this permits delicacy and uniformity of coating or easier modification of its thickness. A layer of soft body paste is now laid over the enamels, the mould is placed on the articulator, and the thickness of the block is built out and shaped in the usual way, compressing it firmly, and removing surplus moisture with bibulous paper or the blowpipe flame. The block is next carefully removed, and while resting in its matrix the platina pins are inserted or holes drilled in the base, or dovetails cut, as may be preferred, and the whole inner surface examined and trimmed. If the inside of the block is to be finished in gum, the enamel should now be applied; then remove the block from the matrix and apply the outside gum enamel and trim between the teeth, where the thin edges of the plaster matrix are apt to be defective; the block is then ready to be dried and placed in the furnace, where it is fired at a single heat without previous biscuiting. The side blocks are made in precisely the same manner.

PORCELAIN PLATES.

In addition to what has already been said upon this subject, it is only necessary here to consider some of the preceding properties and manipulations of the porcelain material in its use as a plate. Neither in itself, nor by known combination with any substances, can a thin porcelain plate be otherwise than frail. The fusible porcelain of the "continuous-gum work" is supported by the platina plate and the continuously soldered platina backings. Such porcelain, without metallic support, would be very frail. In endeavoring to give strength by decreasing the flux and increasing the refractory ingredients, we are at once met by the difficulty of shrinkage. Thus we encounter two horns of a dilemma—a very fusible porcelain with less contraction but great tenderness, a more refractory porcelain with greater strength but the usual one-fifth contraction, which necessarily destroys the fit of the plate if made over the unchanged model.

Dr. Allen frankly acknowledges the weakness of his very beautiful porcelain by giving it a metallic support. The dentist knows just what he is using here (see the fourteenth chapter), and can exercise his judgment upon the suitability of the work to any case in hand. The few dentists who make porcelain plates are more reserved in communicating their knowledge. Such unprofessional reserve is damaging to dentistry as a science; it would injure it also as an art if entire porcelain dentures had a strength equal to their beauty. It is claimed by some makers of these plates that their formulas give a porcelain which is very strong, yet has a very slight shrinkage. But until such formulas are made known to the profession and an opportunity given to test them, the general prejudice against the porcelain base must continue to be well founded. To those desirous of experimenting in this direction we might suggest the use of silicate of magnesia and lime (asbestos) and coarsely pulverized porcelain fragments, as perhaps lessening the shrinkage of the mass.

By some the ordinary dental porcelain paste is used, making provision for shrinkage by enlargement of the model. One method of enlargement is as follows: With a fine saw divide the plaster model by a cut through the median line and another on each side; separate these four sections one-eighth inch and fill the joints with plaster, first saturating them with water; then cut the model twice at right angles to the first lines and fill with plaster as before. If the back of model is perfectly level and the work is very carefully done we shall have a tolerably accurate enlargement of about one-fifth. Make a plaster matrix over this, and into it pour a furnace model composed of three or four parts asbestos or sand to one of plaster. On this mould and carve and bake the plate and teeth; else transfer the plate to a pile of coarse silex so arranged as to give it as much support as possible during the firing.

Teeth and plate are sometimes carved out of the same mass on the enlarged model; or blocks may be made as already described, then transferred and united to a porcelain plate on this model. Sometimes the teeth from the depots are arranged in the porcelain paste and gum enamel applied around the teeth and over the plate. Unlike continuous-gum work, the teeth are not attached to any unyielding plate; hence they are liable to change position by the contraction of the plate during firing.

We cannot more appropriately close this chapter on dental porcelain than by quoting some remarks of the great English ceramic manufacturer, Josiah Wedgwood, applicable to the art which he

did so much to elevate. They have a significance beyond ceramic art, and convey, in this lesson of the past, a warning to those who may, perhaps unconsciously, be dishonoring the profession of their choice.

"All works of taste must bear a price in proportion to the skill, taste, time, expense, and risk attending the invention and manufacture. Those things called dear are, when justly estimated, the cheapest; they are attended with much less profit to the artist than those which everybody calls cheap. Beautiful forms and compositions are not made by chance, nor can they ever, in any material, be made at small expense. A competition for cheapness and not for excellence of workmanship is the most frequent and certain cause of the rapid decay and entire destruction of arts and manufactures."

ŒSOPHAGOTOMY.

As the accident of swallowing artificial dentures has occurred more or less frequently, and has in some cases resulted in death, the following case will describe the operation of removal where all efforts of a more simple nature failed to give relief:*—

"On Sunday, November 14th, 1886, George K. (white), aged thirty-two years, while at dinner had the misfortune to partially swallow his set of artificial teeth, consisting of a rather narrow vulcanite plate for the upper jaw, to which were attached three incisors, one lateral incisor having been lost from the plate. The denture was arrested in its passage downward, producing intense pain and partially obstructing respiration, while deglutition, even of liquids, was rendered impossible. A physician was summoned, who detected the plate in the upper portion of the œsophagus; but all efforts to remove it or force it into the stomach were futile. Sufficient opium to relieve the pain having been administered, on the following day (Monday) he was brought by his physician to the infirmary of the University of Maryland and placed under the care of Dr. L. McLane Tiffany, professor of surgery. On the same afternoon, the patient having been etherized, careful attempts to remove the plate were made, but it was so firmly impacted in the upper portion of the œsophagus that all effort for its removal failed. On Tuesday, in the presence of the medical and dental classes, the patient was again etherized and efforts made to remove the plate through the mouth, but without success.

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* This operation was reported for the *Dental Cosmos* and *Am. Journal of Dental Science* by Prof. F. J. S. Gorgas.

"The patient lying on his back, with his face turned to the right, so as to render the tissues of the left side of the neck tense, Prof. Tiffany made an incision about four inches in length through the integument over the depression between the trachea and the sterno-mastoid muscle. The anterior jugular vein was cut and ligated, and the incision extended from opposite the upper border of the thyroid cartilage nearly as low as the sterno-clavicular articulation. The platysma myoïdes muscle and the cervical fascia were then divided. The edges of the wound being held apart by retractors, the omohyoid muscle was drawn outward, and the sterno-hyoid and sterno-thyroid muscles inward. The carotid sheath, with the contained vessels, was exposed and carefully drawn outward, while the thyroid gland was separated as far as necessary and drawn inward. The larynx and trachea were drawn somewhat forward, and the finger passed behind, where the foreign body could be distinctly felt through the œsophagean wall.

"Care being taken to avoid the recurrent laryngeal nerve, an incision large enough to admit the finger was made into the œsophagus, through which the exact position of the set of teeth was ascertained. Forceps were then introduced and the plate removed intact. The wound, after being thoroughly cleansed, was dressed with antiseptic gauze and absorbent cotton, no sutures being employed. On the following Thursday the patient was walking about his room, having a normal temperature and pulse. He was fed by means of a stomach-tube for six days, after which he was able to swallow liquid food with little or no pain, and the external wound had nearly closed."

CHAPTER XVII.

DEFECTS OF THE PALATINE ORGANS.

One of the most distressing deformities to which the human frame is liable is found in that defective condition of the palatine organs which is known to surgeons by the name of Cleft Palate. The unfortunate sufferer is compelled, in a great measure, to be an alien among his fellow creatures; an object of compassion to the considerate, he is often made painfully conscious of notice by the heartless crowd; and were he gifted with the power and eloquence of

a Demosthenes or with the garrulousness of a Cleon he could make little more use of his endowments than a mute. Fortunately this painful defect is no longer to be reckoned as one of the *opprobria medicorum;* for both surgical and mechanical means are now at hand by which the imperfection may at least be remedied, and often cured.

Defects of the palatine organs may be divided into two classes, viz.: Accidental and Congenital. The first includes all loss of substance in either hard or soft palates, whether occasioned by disease or otherwise. Such defects are not uniform in locality nor in extent, consisting sometimes of simple perforations, and at others involving the destruction of the velum, a considerable portion of the os palati, the vomer and turbinated bones, and the loss of a greater or less number of the teeth. The second class includes all malformations, from the simple bifurcation of the uvula to an opening through the velum, palatine, and maxillary bones, and a fissure of the upper lip; thus uniting the nasal passages with the oral cavity throughout their entire extent.

These malformations are quite similar in character, but not uniform in extent. They may be said to begin with the uvula, and in the uvula and velum always *occupy the median line;* but as the defect progresses anteriorly, it may deflect to one side or the other of the vomer and, following the nasal passage, divide the lip, leaving the vomer articulated with the palatine bone upon one side; while in other cases the deformity seems to follow the median line, and thus involves both nasal passages, terminating in a double fissure of the lip.

Congenital defects of the palate are usually accompanied by more or less deformity of the sides of the alveolar arch and of the teeth. Sometimes the sides of the alveolar ridge are forced too far apart, and at other times they are too near each other; while the teeth are either too large or too small, and are generally of a soft texture with imperfectly developed roots.

Want of coaptation, resulting from defective formation in the palatine plates of the maxillary and palate bone, is the cause of congenital deficiencies of the parts in question. In the human embryo of about the third week the development of the *face* is clearly in progress. Five tubercles bud out from the front of the cephalic mass, of which the middle one (which is double) is directed vertically downward, and bears the appellation *incisive tubercle* because the intermaxillary bones, destined to hold the superior incisor teeth exclusively, are developed in it. On either side is the tubercle, or rudiment, of an upper maxillary bone, which is separated from its

fellow by a wide interval and from the neighboring incisive process by a fissure. The fourth and fifth tubercles, also separated in front, form by their subsequent union in the median line the inferior maxillary bone. At the same period the palate begins to be formed by the approach toward the median line of two horizontal plates, or processes, springing from the maxillary process on either side. (See Development of Bones of Head and Face.)

If, now development proceed regularly and normally, the palate processes of the superior maxillæ meet in the median line and unite with the blended intermaxillary tubercles, while the vomer grows downward to meet the palate processes in their line of union. The upper jaw, after the accomplishment of these changes, is complete, and the formation of the lip and primary dental groove follows in due course. But it sometimes happens that the superior maxillary and intermaxillary processes fail to unite with each other; whence we have the malformation known as *harelip*, or the palate plates are arrested in their growth, and permanent *fissure of the palate* is the result. Consequently, the fissure of single harelip is never exactly in the median line, but on the edge of the intermaxillary bone; whereas, in double harelip, a fissure exists on each side of this bone, in which the four incisor teeth are planted.

FIG. 1054.

Fissure of the hard palate is usually a little lateral, and not median, as it results from a deficiency of one or other of the palate plates of the upper maxillary bone, and it is frequently associated with harelip and fissure of the upper jaw.

The tubercles, or formative processes of the lower jaw, advance and meet in the median line, while the upper maxillary processes are still separate. In man they are consolidated into a single piece; but they remain permanently divided in many of the lower animals by a median suture.

The principal effects resulting from an absence of a portion of the palatine organs are, an impairment of the functions of mastication, deglutition, and speech. Distinct utterance is sometimes wholly destroyed, and mastication and deglutition are often so much embarrassed as to be performed only with great difficulty.

These effects are always in proportion to the extent of the separation or deficiency of the parts. The simple act of triturating the food may not be materially impaired by the absence of a portion—however extensive—of the palatine organs, unless the natural rela-

tions of the teeth of the upper and lower jaws are changed; still, the process is more or less interfered with, as substances taken into the mouth cannot be so readily managed as when the parts are in their natural state. They are liable to escape from the control of the tongue and pass into the cavity of the nose.

In cases of congenital defects of the palate and velum it is difficult to conceive how infants manage to obtain from the breast of the mother or nurse the food necessary for their subsistence; yet, even when the anterior part of the alveolar border and part of the upper lip are wanting, the suggestions of natural instinct enable them, by a peculiar management of tongue and lip, to do it. The expedient resorted to for effecting this process is curious. The nipple, instead of being seized between the tongue, upper lip, and gum, is taken between its lower surface and the under lip and gum, and in this way it manages to extract the nourishment necessary for subsistence and growth. The tongue is thus made to close the opening in the palate and perform the office of an obturator. By contracting the lip and depressing the tongue the milk is drawn from the breast of the mother or nurse. At this young and tender age the child is not conscious of the imperfection of its palate; and it is not until the period arrives when it should begin to make its wants known by words that it feels the importance of the function of speech, and begins to realize the misfortune with which it is afflicted.

As the child arrives at this period, the mechanism of sucking is perfected and is ultimately applied to the mastication of solid aliments. The food, when chewed, is conveyed between the tongue and movable floor (which serves for a *point d'appui*), and it is brought back between the teeth. Thus it is that the complicated operation of mastication and deglutition is performed without the alimentary morsel getting into the nose, or, if this does sometimes happen, it is the result of accident. But in cases of accidental lesion of the palate the individual has not the advantage of this training of the parts during early infancy. Those who are afflicted with accidental lesions, no matter what may be their position and extent, having acquired the habit of eating by placing the aliment upon, and not under, the tongue, can take no nourishment without a part of it getting into the nose. When to this inconvenience is added a change in the natural relation of the teeth of the two jaws, mastication is rendered still more difficult and embarrassing. When this is the case the tubercles of the teeth of one jaw, instead of being received into the depressions of those of the other, strike upon their protuberances, and cannot be made to triturate the food in as thorough and perfect a manner as is required for healthy and easy digestion.

Thus not only is the process of mastication rendered imperfect, but it is also more tedious.

The process of deglutition itself, so long as the velum and uvula are perfect, is not materially affected by a simple perforation of the vault of the palate, although much difficulty may be experienced in conveying alimentary and fluid substances to the fauces and pharynx. But when this curtain is cleft, or is partially or wholly wanting, deglutition is rendered very difficult, for by the contraction of the muscles of the pharynx part of the food is forced up into the nose. The reason of this will appear obvious when we take into consideration the form and function of this movable appendage. When its muscles are relaxed it forms a slightly concave curtain; but in the act of deglutition the muscles contract, raise the velum, and close the opening from the pharynx into the posterior nares. By this valvular arrangement alimentary substances and fluids are prevented from escaping into the nose. It matters not, therefore, whether the imperfection of the velum palati be the result of accident or disease; its effects upon deglutition are the same. In proportion as the lesion or deficiency is great will this operation be rendered difficult and embarrassing. There are cases where, in consequence of an imperfection of the palate, the patient can swallow no fluids without a part being returned by the nose. To obviate this inconvenience the head is thrown sufficiently far back to precipitate them into the œsophagus. This is an expedient to which many thus affected have been compelled to resort.

Imperfection of speech always results from an opening in the palate; it gives the voice a nasal twang and renders the formation of some sounds impossible. The loss of the teeth, to a less extent, is productive of the same effect. To comprehend fully the manner in which a lesion of the palate may affect the utterance of speech, it will be necessary to understand the agency which the several parts of the mouth have in the formation of articulate sounds. Speech consists in the sounds produced by the organs of the glottis modified by the organs of the mouth. The modulation of the voice, that is, the raising or lowering of its pitch, is accomplished by the vocal cords of the glottis; but the articulation of the consonants requires the co-operation of all the movable and fixed parts of the mouth and pharynx, palate, tongue, lips, teeth, and palatine arch. Hence if any of these be defective or wanting, the power of forming some of these sounds is wholly lost, of others very much impaired; hence, also, the ability to sing is much less interfered with than the power of distinct speech. The tongue has a remarkable power of adapting itself to the loss of teeth and of some other parts, so as

measurably to correct the effect on speech; but the effect of the loss of the hard or soft palate upon the voice cannot be remedied in any such way.

In both cases (accidental and congenital) the faculty of distinct articulate speech is seriously impaired by defects of any extent. In ordinary cases of congenital deformity in an adult, deglutition is not materially interfered with. The patient, having never known any other method of swallowing, is not conscious of any difficulty. Accidental lesions, however, coming generally in adult life, produce, in this respect, very great inconvenience. The remedy for these evils must be the closing of the abnormal passage by some means which will restore to the deformed organs their functions. In perforations of the hard palate, unless of extraordinary extent, the method is very simple. In the loss of the soft palate by disease the remedy is more difficult, and in extensive congenital deformity still more complicated means must be resorted to.

STAPHYLORRHAPHY.

The operation which is resorted to in the treatment of fissured palate is known by the name of Staphylorrhaphy, a word of Greek derivation, signifying suture of the uvula. It is an operation which has been perfectly successful in many instances, although there are numerous cases which will derive far more benefit from mechanical assistance than from the surgeon's aid.

In considering the operation a brief sketch will be given of the anatomy of the parts concerned in its performance; this will be followed by a description of the various kinds of clefts; we shall then describe the means adopted by different surgeons for their relief or cure. To obtain success in staphylorrhaphy, the first care must be to gain a practical acquaintance with the position and relation of the muscles connected with the palate and fauces; and this can be accomplished best by laying open the pharynx from behind, for thus the posterior surface of the soft palate is at once exposed to view. We shall find that this structure is wholly composed of muscular tissue covered with a layer of mucous membrane continuous with that lining the hard palate.

The muscles with which we have chiefly to do are: the palato-glossi and the palato-pharyngei, forming the anterior and the posterior pillars of the soft palate respectively; the levatores palati, the tensores palati, and the azygos uvulæ.

The levator palati is a long, rounded muscle lying obliquely on the

outer side of the posterior opening of the nares. It takes its origin from the petrous portion of the temporal bone and from the cartilage of the Eustachian tube, and then descends obliquely downward and inward, its fibres spreading out over the posterior surface of the soft palate until they meet with those of the corresponding muscle on the opposite side.

The palato-glossus is a very small muscle arising from the anterior surface of the soft palate on each side of the uvula, whence it passes forward and outward to be inserted into the dorsum of the tongue, thus forming the anterior pillar of the fauces.

The palato-pharyngeus is separated from the preceding muscle by a space in which the tonsil lies. It arises, by two origins, from the soft palate, and descending outward and downward, is inserted into the posterior border of the thyroid cartilage.

The tensor palati arises from three points, viz.: first, from the scaphoid fossa, at the base of the internal pterygoid plate; secondly, from the cartilaginous portion of the Eustachian tube; and, thirdly, from the spinous process of the sphenoid bone; it then terminates in a tendon which winds around the hamular process, which may be plainly discovered with the finger about half an inch behind the tuberosity of the superior maxilla; and it then passes horizontally and expands into a broad aponeurosis on the anterior surface of the soft palate.

The azygos uvulæ arises from the posterior nasal spine of the palate bone and from the aponeurosis of the soft palate, and descends to be inserted into the uvula.

Having learned the attachment of these muscles, it will be well to consider their respective actions upon the palate, in order more clearly to comprehend their relations to the separated portions of a cleft palate. The levatores palati slightly raise the soft palate while it is made tense by the action of the tensor palati. The palato-pharyngei contract and bring the two sides of the palate from whence their fibres arise in close contact together.

The action of these muscles show what an important part they must bear in regard to the operation of staphylorrhaphy; and when this is considered in detail, it will be seen why but little success was met with until means were found to render muscular action of the parts impossible.

The deficiency of the palate varies considerably, from a mere division of the uvula to a gap which constitutes a hopeless deformity. When this abnormal state is limited to the soft palate, the cleft is always of a triangular shape, the apex being above and the base

below; but when the soft and hard structures are involved, it is of a more or less quadrilateral shape.

We shall here only consider those cases which are congenital in their origin, merely alluding to the distinction between this class of deformity and that kind which may be said to be acquired, or is accidental. In congenital cleft the fissure is generally confined to the median line of the palate, because the two halves have not united at that part at the usual period. In acquired or accidental deformity lesions are met with in all parts of the palate, to the right or left of the median line, and are usually the result of syphilitic ulceration, or have some traumatic origin.

Congenital clefts may be thus classed: Firstly, a small, triangular-shaped fissure, extending through the uvula and the posterior portion of the velum palati, the other portion of the palate being quite intact and sound. Secondly, the whole of the soft palate is involved. Thirdly, the soft palate and a portion of the palate bone is deficient. Fourthly, the cleft may be associated with abnormality in the alveolar process of the palate bone, and even with harelip. Fifthly, openings occur in the hard palate, the soft palate being unaffected. These separations may be very narrow, not exceeding a few lines in width, or the gap may be such that mouth and nostril seem but one.

The fissure posteriorly is *always on the median line;* anteriorly, it generally deflects to one side or the other of the nasal septum, passing also to one side of the inter-maxillary bone. In some rare cases both nasal passages are involved, and a double harelip is the consequence. The effects of this condition, already stated, may thus be briefly summed up. During infancy the functions of suction and deglutition are with difficulty performed, and at a later stage mastication and articulation are much impeded. There is also imperfect control over the muscles of the palate, both fluids and solids are liable to pass into the windpipe, and not unfrequently there is regurgitation through the nose. The speech is guttural and nasal, often so indistinct as to render it almost entirely unintelligible, and the patient is only too anxious to grasp at any chance that may be held out as being likely to grant some amelioration of his condition.

Various methods have been suggested for the cure of this deformity. Some have proposed to close the cleft in early infancy by means of pressure on the yielding bones; others maintain that artificial substitutes are best adapted to relieve the patient's suffering; while others as strenuously proclaim the knife to be the only means whereby success may be obtained.

The first surgeon who directed serious attention to the operation was M. Roux, a notable French surgeon, who performed it upon a young American physician in the year 1825. Velpeau informs us that M. Colombe, another Frenchman, performed the operation on *the cadaver* in 1813, being probably actuated to attempt its performance by reading the successful efforts of a French dentist (Le Monnier) to cure cleft palate by surgical procedure as early as 1764. For more than fifty years after this date the operation seems to have been forgotten or to have fallen into disuse, until it was revived by M. Roux, in France, and almost simultaneously by Dr. John C. Warren, of Boston, each of whom seems to have performed the operation in total ignorance of what was done by the other.

In 1827 Dr. Stevens, of New York, operated with success; in the succeeding year Dr. Mettauer, of Virginia, followed in the footsteps

FIG. 1055.

FIG. 1056.

of his confreres in the profession, and embodied his experience of staphylorrhaphy in a very interesting article which appeared in 1837. The operation also attracted attention in England, where we believe it was performed for the first time by Mr. Alcock, in 1822. Since then it has become one of the most frequent operations in surgery, and, through the suggestions and improvements made by Hamilton and Dieffenbach, by Fergusson, Pollock, and Mason, it has served still further to enhance the benefits which it is the privilege of the surgeon's art to extend to all mankind.

The operations of M. Roux and Dr. Warren were very similar in character, and we think that equal credit must be extended to the

Frenchman and to the American for the revival of staphylorrhaphy; while English surgery deserves no little credit for the suggestions of men like Pollock and Fergusson, which have contributed so much to its present success.

All the earlier operations of staphylorrhaphy consisted in paring away the edges of the cleft, and then bringing them in contact by means of sutures until union was effected. The various stages of the operation as then performed are sufficiently illustrated in the accompanying engravings, the successive steps being taken in the order of these drawings. Many modifications of this plan were made by Warren, Mettauer, Stevens, Graefe, and others; but Fergusson introduced

FIG. 1057. FIG. 1058.

a new principle of treatment in the operation which has very materially added to its successful results.

We have alluded to the use of the muscles composing the velum of the palate and their important action on it, and to Fergusson must be assigned the credit of being the first to realize practically the fact that muscular action was the most frequent cause of failure of the operation; and he proved the truth of his conjecture by his method of removing the difficulty; namely, the division of the muscles of the palate, thus entirely paralyzing their action.

Prior to this discovery Sir Wm. Fergusson had adopted an operation somewhat similar to Warren's and founded on that of Roux, which was performed as follows: The patient was placed in a chair with a back slightly more inclined than usual; his head being then well supported and his mouth kept open by means of a gag, the

edges of the fissured palate were pared from above downward, with a curved bistoury. Next a curved needle, with a movable eye, armed with a strong silken ligature, was passed through the palate, at the upper angle of the wound, at a distance of about a line from the fissure. The other edge was transfixed in a similar manner. Two other ligatures were then inserted in the same way, the third and last being as close as possible to the extremity of the wound. The threads were then seized with the fingers and tied, being very careful to avoid pressure of the knot upon the middle of the wound. This earlier operation of Mr. Fergusson, which was the type of many others that have been proposed, and which is substantially the same as that illustrated by the figures before referred to, has been described in order that the improvement in the modern operation may be the more fully appreciated when it is subsequently described at length.

FIG. 1059.

Preparation of the Patient.—Mr. Hamilton Cartwright, of the Royal College of Surgeons, London, makes the following suggestions for the preparation of the patient. Before undertaking the operation of staphylorrhaphy various points have to be considered. Firstly, having decided that a surgical operation will be of more benefit to the patient than mechanical aid, cognizance must be taken of his general health; for upon its good condition much of success must ultimately depend. Should the patient be chlorotic or anæmic, the operation must be postponed until after a proper treatment. A healthy regimen must be prescribed; frequent but not fatiguing exercise in the open air must be insisted upon, and tonics must be given, their character being determined by the patient's diathesis. Particular care must be shown in cases of struma, as there is no condition in which the parts are more unlikely to heal favorably than in this. For the relief of this condition it may be necessary to devote great attention for many months. Sea air will be of much service, while its effects will be enhanced by giving a course of iron. Mr. Cartwright recommends particularly two chalybeate preparations, which are of the greatest value in anæmia, as well as in that diathesis now under consideration. They are the syrup of the iodide

of iron and the syrup of the hypophosphate of iron and manganese. The latter acts as a tonic and an alterative; at the same time it keeps up an easy action upon the bowels; indeed, there is no medicine which he has found more rapidly successful in improving those weak and enfeebled states of the system which are owing to scrofula or to an impoverished condition of the blood. Nothing has more conduced to bring staphylorrhaphy into disrepute than a disregard of the physical condition of the patient; good health is the *sine qua non* of rapid and successful union of the parts.

Having suited the treatment to the indications of the case, it is of the utmost importance that the patient be educated, so to speak, to assist the surgeon in the operation which he is about to undertake; for the fauces are intensely sensitive, and were the condition of the parts forgotten, the retchings and convulsive movements so easily induced in them would probably cause a failure in the proposed cure. Various means of lessening this sensibility have been suggested; some have recommended rough fingering of the parts daily; and Dr. Garretson proposes to occasionally pass a tenaculum through the parts to be operated upon, a treatment which we rather think would make the patient more fearful than ever of the operation. As good a method as any proposed is to enjoin the friends of the patient, or the patient himself, if old enough, to irritate the fauces with the feather of a quill; in a few weeks it will be found that the parts will become tolerant of almost any irritation. The same results may be obtained by wearing an obdurator extending far back over the palate; the irritation at first produced by it will soon disappear, and after wearing it constantly for a few weeks all the usual symptoms produced by interference with the fauces will have passed away.

Mr. Cartwright proposes another method of treatment, which is somewhat novel, but most successful in its results. It has been found that the exhibition of the bromide of potassium tends to deaden the sensibility of the fauces in a very remarkable manner, and thus it may become a most useful agent preparatory to the operation. If exhibited in half-drachm doses, given thrice daily for two or three weeks prior to the period decided upon, but little irritability of the parts will be found remaining; and by the time a few imaginary operations on the parts have been performed, by the aid of such harmless instruments as a camel's-hair brush or the feather of a quill, the patient will be found in a fit condition to be operated upon. A few days prior to the time of operating more particular attention must be paid to the condition of the patient. Primarily, he must be well nourished, inasmuch as he will be forced to adopt

a different regimen from that to which he has been accustomed for some days. His diet must be nutritious without being stimulating, and the greatest attention must be given to the regular action of the bowels, and, indeed, in all cases it is well to give a mild aperient before operating.

The patient having been thus prepared, much of the success of the operation will depend upon his ability to remain tranquil during its performance, and to give as much assistance to the surgeon as may lie in his power. Thus he may assist the operator by opening his mouth widely, by not resisting the introduction of instruments, and, subsequently, by keeping the newly-connected parts as quiet as possible by restraining the movements necessarily induced by deglutition or by attempts at articulation. It will thus be seen why the operation for cleft palate must be delayed until the patient is old enough to exercise control over his movements. The best period is from nine to ten years of age, although Sir Wm. Fergusson has frequently operated much earlier with complete success.

As before observed, the pioneers who cleared the way for the success of staphylorrhaphy were Roux and Warren, and many modifications of their plans have been made from time to time by others; but the man who introduced a new era in the history of the operation was Sir Wm. Fergusson, of London, who has rendered it most perfect in all its details. This credit being generally conceded to him, we shall describe his mode of operating as the type of operations generally performed in modern days.

Warren divided the pillars of the fauces empirically, with a view, as he states, of relieving the tension of the parts; but nowhere do we find that he speaks specifically of dividing the muscles contained in them; it remained for Mr. Fergusson to point out that muscular action was the great cause of failure in most cases, and he practically proved the truth of his conjecture by resorting to the operation of myotomy, dividing the muscles of the palate, and thus paralyzing their movements. He found that the tension on the line of union was principally exercised by the levator palati and by the levator pharyngeus, and he then proposed the following operation:—

Sir Wm. Fergusson's Operation.—Mr. Cartwright describes Mr. Fergusson's operation as follows: He first divides the muscles of the palate by passing a curved knife around between the velum palati and the end of the Eustachian tube, thus at once dividing the levator palati. In the second stage he seizes the uvula, thus bringing forward the posterior pillar of the fauces, which is snipped across with round-pointed scissors, so as to divide the fibres of the palato-pharyngeus muscle; should it be deemed necessary to do so, the

anterior pillar may be divided at the same time, so as to sever the palato-glossus, though Sir William lays no stress upon the necessity of doing so. Next, the uvula is again seized, with a view of extending the palate so that the edges of the fissure may be pared away; this is accomplished with a narrow bistoury from behind forward, on either side alternately, the angle of union being left for subsequent removal. A few moments then are granted to the patient to recover, and he is permitted to swallow a few small pieces of ice, with the double view of refreshing him and of staunching the bleeding. When this has sufficiently ceased, it is time to introduce the sutures, and this is done by means of a nævus needle, armed with a silken ligature, the needle being introduced about a quarter of an inch from the edge of the fissure. Next, the extremity of the thread is pulled out by means of forceps, and another ligature is passed in like manner, until the desired number of stitches is attained. The extremities must then be tied loosely, so as just to keep the parts in apposition and no more; after which the patient is put to bed, every care being taken to avoid all motion of the palate. He should take nothing but nourishing liquid food for a few days, and must be particularly enjoined to abstain from all movements involving action of the muscles engaged in deglutition, such as swallowing, coughing, sneezing, and the like, which would much endanger the success of the operation. The next stage consists in the removal of the stitches; this need not be done too soon, provided they produce no irritation; indeed, they may remain until union is perfect. The general time for their removal is about the seventh or eighth day, although Fergusson often removes them on the third or fourth.

Mr. G. Pollock has introduced the following modifications in the performance of this operation: Instead of dividing the muscle with a curved knife from behind, according to the method we have just described, Mr. Pollock passes a ligature through the soft palate, so as to contract and draw it forward, and he then pushes a narrow-bladed knife through it, a little to the inner side of the hamular process of the pterygoid plate of the sphenoid bone, which may be plainly discovered by passing the finger along the roof of the mouth to a distance a little posterior to the tuberosity of the superior maxilla. By raising the hand, and so depressing the point of the scalpel, he most effectively, and in a very simple manner, divides the muscle. The parts having healed, the patient must be impressed with the necessity of practicing himself frequently in elocution, telling him that his success in articulation will depend upon himself alone. Constant, patient, persevering effort will be necessary, and the end to be attained must be sought by distinctly articulating

every syllable of every word which he may be called upon to utter. It is a good exercise to read a portion of some good author each day with a friend, who will assume the role of schoolmaster for the time being, permitting no word to be indistinctly uttered or slurred over and requiring each syllable to be correctly and separately pronounced.

Fissure of the hard palate, simple or connected with a fissure of the soft. Various means of closure have been proposed. Dr. Warren dissects the mucous membrane from the bone on either side, carrying his knife sufficiently forward toward the alveolar border to form a flap broad enough to meet a like one from the opposing

Fig. 1060. Fig. 1061.

side along the median line. When the fissure is so wide as to prevent the margins being brought together, Dr. Mettauer, of Virginia, recommends making several lateral incisions through the mucous membrane, with a view of permitting the edges to be brought into close apposition. Dr. Mütter, of Philadelphia, who was very successful in the operation, also had recourse to the longitudinal incision (as shown by Fig. 1060), which was first proposed by Dieffenbach, with the most happy results. Dr. Warren's operation has been introduced into England by Mr. Pollock, who, with his peculiarly constructed instruments, proceeds as follows: He makes an incision along the edge of the cleft at the juncture of the nasal and palatal mucous membrane. The soft covering of the hard palate is carefully dissected or scraped from the bone with curved knives, great care being taken that the mucous membrane and its subjacent fibro-cellular tissue are not perforated. When this has been well

loosened on either side, it will be found to hang down like a curtain from the vault of the mouth, the two parts coming into apposition along the median line, or possibly overlapping. The edges, being then smoothly pared, are brought together by means of a few points of suture introduced in the ordinary way and without any dragging. Where the hole is not very large, Dr. Pancoast's ingenious operation of staphyloplasty may be performed, in which he raises two flaps of mucous membrane from the bone on either side, and then, reflecting them across the chasm, their edges are brought together by suture in the usual manner, a plan which is so perfectly exhibited in Fig. 1061 that we do not deem any further description necessary. Recently M. Langenbeck has suggested another operation, in which he proposes to dissect the mucous membrane, together with the periosteum, from the surface of the bone prior to bringing the opposed surfaces of the cleft in apposition; and the advantage claimed by him for this, which he considers to be a novel method of procedure, is that the chasm is obliterated, not merely by soft tissue, but by bone, which is formed from the periosteum thus loosened from contact with the surface of the hard palate. If this theory be correct, we cannot but think that Dr. Warren and Mr. Pollock must have met with like results, although it is remarkable that they seem to have been unconscious of the great advances they had thus made in the treatment of cleft palate by the operation which the one proposed and the other carried out. We deem it impossible that Warren should have merely raised the mucous membrane without the periosteum attached to it—a dissection so difficult that we could excuse the ablest surgeon for not accomplishing such a separation when operating on the living subject without lesion of the mucous tissue; and until an autopsy reveals to us that real osseous tissue has filled up the breach in the continuity of the palate bone, we must confess that we shall remain skeptical as to the results now claimed by Herr Langenbeck and others for their revival of Dr. Warren's old operation.

There is one other treatment which we have mentioned, and to which we must make a short allusion, and that is the method of closing fissure of the hard palate by means of pressure. Velpeau proposed to take advantage of the yielding character of young bone by adopting mechanical means which would bring the parts separated into closer or even perfect coaptation; this idea of his has recently been more fully worked out by more modern experimentalists, who speak highly of the success which has crowned their efforts. The method of cure may be thus briefly described: A

clamp or compressor, with pads arranged according to the exigencies of the case, is applied on either side of the alveolar arch; the edges of the fissure and of the bone having been pared away, the action of a screw is brought to bear upon the instrument until the soft and pliant bones are brought together. That there are grave disadvantages attendant on this mode of treatment cannot fail to appear to every dentist. Firstly, the alveoli of the superior maxilla are thrown within those of the alveolar border of the inferior maxillary bone, thus laying the foundation of serious deformity in after-life. Secondly, the germs of the teeth might be so affected as to induce subsequent irregularity and malposition. Thirdly, there is danger of inflammation being excited, while the delicate physique of the young child runs great risk of being affected injuriously by the irritation resulting from constant wearing of such an instrument as that described. Lastly, we must consider the chance of fracture by exercising too much compressive power upon the bones. This hazard is acknowledged by those who advocate the proposed operation of Velpeau; but they excuse themselves by urging that even should fracture occur it would be of little consequence, inasmuch as the injured parts are kept in splints, and that, therefore, the treatment which would be correct in the one case is already provided for the other. It is to be feared that this admission will rather deter others from attempting an operation in which much evil may be done for an uncertain possible future good. The fact is more and more acknowledged in the humane surgery of the present day that the gentler the means, if equal to the end proposed, the more entitled is any treatment to recognition and to praise.

In the usual operation of staphylorrhaphy certain muscles most important to speech have to be divided; and it is upon this very division of them that its success, in an operative point of view, so much depends, while it is an important question whether the muscles are not thus, in spite of their reunion, to a certain extent deprived of power; and this we believe to be the reason why articulation is often so little improved after the successful performance of the operation in question. Hence we propose that surgical and mechanical skill should combine to produce more perfect results in the treatment of fissured palate. We have been led to make this proposition by the success which has attended our efforts in cases where surgery has been but partially successful in her attempts to secure perfect union and coaptation of the opposing edges of the cleft, thus leaving a gap in the anterior portion of the original fissure while the posterior parts are well united. The operation which we suggest is to pare the edges of the halves of the bifurcated

uvula and the posterior portion of the soft palate nearest to them, and to bring about the union of these parts in the usual manner by means of suture. Union having been effected, the deficiency in the anterior portion of the palate is to be filled by means of an artificial velum ; the artificial velum at the same time extending backward and nearly filling the pharynx. The advantages of this combined operation are very manifest; for the muscles, being uninjured, their action is nearly normal, and the great objection of bringing about a too dense condition of the newly united palate is avoided, this being another of the causes which prevent great improvement of articulation as a result of staphylorrhaphy. Now, in the partial operation just described, these disadvantages are at once removed, and the gap which still remains after the reunion of the uvula being filled up by the artificial palate attached to an oburator, the muscles still have their normal play, and the palatine deficiency is better supplied than by the natural union of the separated edges of the cleft. The best results have been obtained by this most simple means of action. Figs. 1075 and 1077, being illustrations of cases occurring in the writer's practice, show very forcibly the manner of the proposed treatment, Fig. 1077 being an especially interesting case, because the operation of staphylorrhaphy, surgically considered, had been most successfully performed, but articulation seemed but little improved. The patient was willing to be the subject of an experiment, and the anterior portion of the reunited cleft was opened up again and a velum with an obturator introduced in the space thus created. The results were eminently satisfactory; the tension of the soft parts was at once relieved by this division, and after a little practice the patient spoke as she had never spoken before.

There are many cases of abnormality in the os palati which can only be relieved by mechanical appliances, and this relief can be afforded in a most satisfactory manner, no more inconvenience being felt by the patient than he would experience in wearing an artificial denture, with which the false palate could be connected, were it necessary to do so. Artificial aid has been several times alluded to in reference to the operation of staphylorrhaphy, and, indeed, it is still an open question whether in a large number of cases the greatest relief is not afforded by mechanical appliances. The surgeon's only desire should be to recommend that plan of treatment which he considers will ultimately render the greatest service to his patient. Undoubtedly, the operations which have been described are often, as far as mere union is concerned, most satisfactory in their results; but there are other considerations besides

these. Naturally the chief desire of the patient is to take a footing in society on equal terms with other men; and there are no means which will enable him to do so, unless they can restore to him his lost or impaired power of speech—that divine gift which places man so immeasurably above the brute creation. This has been almost lost in many cases of cleft palate; and it is the great object of treatment to put the sufferer in a way of uttering his thoughts in plainly-spoken words like those around him; whatever means are best calculated to bestow this inestimable benefit are those which the conscientious surgeon ought to select.

There are certain cases where the opening is not large, and as there is little tension of the parts the opposite sides come together in close proximity; staphylorrhaphy may here be performed with good results, for it must be recollected that it is always a desideratum to avoid the presence of foreign substance as a substitute for natural tissues, if these are equally effective. Allusion has been made to the liability to injury of the parts by a division of the muscles. Where an artificial palate is used the muscles are unimpaired; and we have heard persons, who when without the instrument could not be understood, speak fluently and distinctly the moment they introduced it into their mouths. So far as the discomforts of wearing such an apparatus are concerned, after a short time the wearers become entirely unconscious that they are wearing anything artificial.

OBTURATORS AND ARTIFICIAL PALATES.

We have classified palatine defects as accidental and congenital; we shall also classify the appliances used for their remedy. The term *obturator* will be used for all instruments intended to stop or close all those openings in the hard or soft palate which have a complete boundary. Appliances made to supply the loss of the posterior soft palate, whether accidental or congenital, will be called *artificial vela* or *artificial palates.*

Any unnatural opening between the oral and nasal cavities which will permit the free passage of the breath will impair articulation. Any appliance which will close such passage and can be worn without inconvenience will restore articulation.* Obturators were formerly made of metallic plate, gold or silver being most commonly

* The student will bear in mind that no cognizance is here taken of openings similar to those described in cases of congenital fissure, where the surgeon has united the soft palate, and left an opening through the hard palate to be covered by an obturator.

employed, and many very ingenious pieces of mechanism were the result of such efforts; but latterly vulcanized rubber has almost entirely superseded the use of metals. Vulcanite has been found preferable to metals, being much lighter and much more easily formed and adapted, particularly when of peculiar shape.

According to Guillemeau, obturators were employed by the Greek physicians; but it is to that celebrated French surgeon, Ambrose Paré, that we are indebted for the first description of an appliance of this sort. This author has furnished an engraving of an obturator which he had constructed in 1585, consisting of a metallic plate, probably of silver or gold, fitted into an opening in the vault of the palate. It was held up by means of a piece of sponge fastened to a screw in an upright attached to the upper surface of the plate. The employment of sponge, however, was found to be objectionable, as the secretions of the nasal cavities which it absorbed soon became insufferably offensive; notwithstanding which, it continued to be used for a long time. Ultimately, however, it was superseded by an obturator invented by Fauchard. This was held up by means of wings which turned on a pivot. Both of these obturators, however, exerted a hurtful influence upon the surrounding parts, as the pressure produced by the sponge and wings caused them to be gradually destroyed, and thus augmented the evil they were designed to remedy; consequently, their use has been wholly abandoned. We do not, therefore, deem it necessary to give a description of either. We will, however, quote a passage from Bourdet upon the subject. In alluding to the impropriety of having recourse to any appliance which has a tendency to counteract the curative efforts of nature, he says: "Before considering the cicatrized perforations of the palate as being of a nature incapable of diminishing in diameter, practitioners should satisfy themselves, thoroughly and beyond doubt, that such is the case. We do not think that this condition of permanency can exist, for positive facts attest the contrary; and as holes made in the cranium with the trepan close almost entirely, in like manner those of the palate constantly diminish." Numerous examples might be adduced, if it were necessary, to prove the impropriety of sustaining an obturator by any fixtures which act upon the lateral parts, as they necessarily tend to increase the dimensions of the opening in the palate.

Where atmospheric pressure cannot be obtained and there are no teeth for clasping, the use of spiral springs attached to a partial lower piece or to caps placed over the lower molars would be preferable to this very objectionable prominence on the upper surface of obturators. It is of the greatest importance that an artificial

palate or obturator should be executed in the most perfect manner, and be made to fit accurately to all the parts with which it is to be in contact, so that it may not produce the slightest irritation or exert undue pressure upon any of the surrounding parts. As in the case of the application of a dental substitute, the piece should not be applied while any of the teeth, especially those of the upper jaw, are in an unhealthy condition. The gums and sockets of the teeth should also be free from disease.

With a view of obviating the objections which have been mentioned as existing to the obturators of Paré and Fauchard, Bourdet proposed to employ simply a metallic plate fitted to the vault of the palate and large enough to cover the opening, with two lateral prolongations, one on each side, extending to the teeth, to which they are fastened by means of ligatures. This was also found to be objectionable, as the ligatures were productive of constant irritation to the gums; moreover, they did not hold the plate in place with sufficient stability, and its use was soon abandoned. But these ob-

FIG. 1062. FIG 1063.

jections were both obviated by an improvement made by M. Delabarre, which consisted in the employment of clasps, instead of ligatures, attached to lateral branches of the plate. To prevent these from slipping too high up on the teeth he attached to each a kind of spur, which was so bent as to come down over the grinding surface of the tooth to which it was applied. The last-named author also made another modification, which consisted in the application of a drum to the upper surface of the plate (Fig. 1062). The object of this was to prevent the accumulation of mucous fluids from the nose in the *cul-de-sac*, formed by simply closing the opening below; also to prevent fluids, in swallowing, from passing up between the obturator and the soft parts through the opening into the nose. The drum evidently offers the same impediment to nature's efforts in

closing the opening as the obturator before mentioned; on this score, therefore, it is equally objectionable.

When the opening in the palate is small, and has *no connection with the velum*, it is unnecessary to raise the upper surface of the plate by attaching a drum or air chamber to it. If it be accurately fitted to the vault of the palate, it will effectually prevent fluids, in deglutition, from passing up in the nasal cavities, or the escape of any portion of the voice through the opening; also by frequently removing the plate the accumulation of the secretions in the *cul de sac* will be prevented. A simple plate, like the one represented in Fig. 1063, will be all that is required to remedy the defect; and this, in fact, will probably be found the best form in all cases, whether the openings be large or small.

Fig. 1064 represents an obturator without teeth and without clasps for a perforation of the hard palate, being sustained *in situ* by im-

FIG. 1064.

FIG 1065.

pinging upon the natural teeth with which it comes in contact. Accuracy of adaptation and delicacy in form are all that is essential in such cases, and the restoration of the speech will follow immediately.

A clumsy contrivance will interfere with articulation almost as much as it is improved by stopping the opening; therefore, if the obturator could be confined entirely to the opening, like a cork in a bottle, it would be more desirable. As this cannot be, resort must be had to clasping the contiguous teeth, if there are any; if there are none, the obturator must extend over the whole jaw and receive its support in the same manner as would a set of artificial teeth. In fact, this is precisely what it becomes in such a case—an upper set of teeth bridging over and filling up an opening in the palate, thus combining an obturator with a denture. Fig. 1065 represents a more complicated obturator, adapted to an opening in the soft palate. The necessity for a variation in the plan will be found in the

anatomical fact of the constant muscular action of the soft palate, which would not permit, without irritation, the presence of an immovable fixture. This is contrived, therefore, with a joint, which will permit the part attached to the teeth to remain stationary, while the obturator proper is carried up or down as moved by the muscles. The joint, A, should occupy the position of the junction of the hard and soft palates. The joint and principal part of the appliance is made of gold, the obturator of vulcanite. The projection, B, lies like a flange upon the superior surface of the palate and sustains it; otherwise the mobility of the joint would allow it to drop out of the opening. This flange is better seen in the side view, marked C. It is readily placed in position by entering the obturator first, and carrying the clasps to the teeth subsequently.

Figs. 1064 and 1065 will illustrate the essential principles involved in all obturators. The ingenuity of the dentist will often be taxed in their application, as the cases requiring such appliances all vary in form and magnitude. The steps to be taken in the formation of an obturator are not unlike those used in making a base for artificial teeth. It is essential that an accurate model be obtained of the opening, the adjacent palatal surface, and the teeth, if any remain in the jaw. For this purpose an impression taken in plaster is the only kind to be relied upon. Care must be used that a surplus of plaster is not forced through the opening, thus preventing the withdrawal of the impression by an accumulated and hardened mass larger than the opening through which it passed. To avoid this, beginners or timid operators had better take an impression in the usual manner with wax. If this is forced through, it can be easily removed without injury to the patient. From this wax impression make a plaster model, and upon this plaster model form an impression cup of sheet gutta-percha, using a stick, a piece of wire, strip of metal, or any other convenient thing for a handle. This extemporized impression cup must not impinge upon the borders of the opening, neither should it enter to any extent. With a uniform film of soft plaster, of from one-sixteenth to one-eighth of an inch in thickness, laid over this cup a correct impression can be taken without any surplus to give anxiety. Upon a correct plaster model taken from such an impression the obturator should be moulded out of gutta-percha or any other plastic substance, the subsequent steps being in principle the same as in making any other piece of vulcanite. It is desirable that it should enter the perforation and restore, as far as possible, the lost portion of the palate; but it must not intrude into, or in any way obstruct, the nasal passage. *The entire freedom of the nasal passage is essential to the purity of articulation.*

That portion of the obturator which occupies the oral cavity should be made as delicate as possible, consistent with its strength and durability.

ARTIFICIAL PALATES.

Before proceeding to a description of artificial palates, a brief reference to the anatomical relations and functions of the *velum palati* will be necessary. The palate exercises quite as important an office in the articulation of the voice as does the tongue or lips. Being a muscular and movable partition to separate the nasal and oral cavities, one edge is attached to the border of the hard palate, while the other vibrates between the pharynx and the tongue. The voice, therefore, as it issues from the larynx, is directed by the palate entirely into the mouth or through the nose, or permitted to pass both ways.

A very slight deviation in this organ from its natural form will make the voice give a different sound; so the presence of anything that clogs the natural passages, either oral or nasal, modifies the vocal vibrations. Place any obstruction in the nasal passages, paralyze the soft palate, or let it be deficient in size, and the power of distinct articulation is wanting. Evidence of this statement is very frequently found after the surgeon has successfully performed the operation of staphylorrhaphy in case of congenital fissure. In such instances (with rare exceptions) the newly-formed palate is so deficient in length and so tense as to be deprived of its function. It cannot be raised so as to meet the pharynx and shut off the nasal passage, but hangs like an immovable septum to divide the column of sound.

Fig. 1066 represents a defective palate belonging to the first class, the uvula and a portion of the contiguous soft palate being destroyed by disease. In such a case an obturator would be useless; the constant activity of the surrounding parts would not tolerate it. The material used for a substitute must be soft, flexible, and elastic; and the elastic vulcanite is admirably adapted to this purpose.

By observing the cut (Fig. 1066), it will be seen that a portion of the soft palate along the median line remains, and consequently there will be considerable muscular movement which must be provided for and which may be taken advantage of. It is desirable to make this movement available in using an artificial palate, as thereby more delicate sounds are produced than otherwise.

This case presented some extraordinary difficulties in the fact that all the teeth of the upper jaw had been extracted; and it was

necessary, therefore, to adapt a plate which should not only sustain the teeth for mastication, but bear the additional responsibility of supporting the artificial palate. In the choice of material best adapted as a base for the teeth in such instances, it is preferable to adopt that which will prove the most durable. There are too many interests involved to risk the adoption of anything but the best. In the case under description the patient desired duplicates, and two sets of teeth were made, one on gold and the other on platina, with continuous gum. The plates were made like other sets of teeth,

Fig. 1066.

with the exception of a groove located on the median line at the posterior edge to receive the attachment for the palate (marked C in Fig. 1067).

Fig. 1067 will indicate the set of teeth with palate attached. The wings, marked A and B, are made of soft rubber; the frame to support them is made of gold, with a joint to provide for the perpendicular motion of the natural palate, as in the case of the obturator represented in Fig. 1065. When the artificial palate is in use, the joint and frame immediately contiguous lie close to the roof of the mouth; the rubber wing, letter A, bridges across the opening on the inferior surface of side next the tongue; the wing, letter B, bridges across the opening on the superior or nasal surface, and is also prolonged backward until it nearly touches the muscles of the pharynx when they are in repose.

Both these wings reach beyond the boundary of the opening and rest on the surface of the soft palate for a distance of from one-eighth to one-quarter of an inch, thus embracing the entire free edge

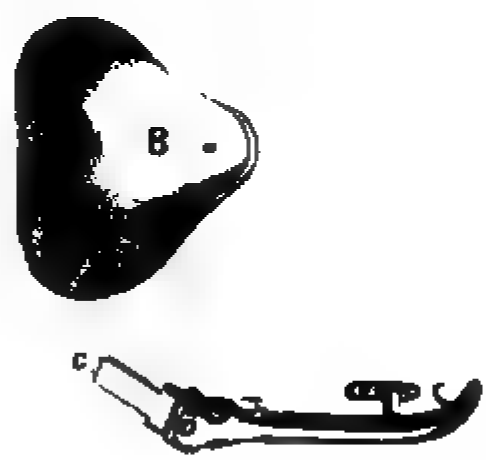
of the soft palate. This last provision enables the natural palate to carry the artificial palate up or down, as articulation may require.

When the organs of speech are in repose there is an opening behind the palate sufficient for respiration through the nares. When these organs are in action, a slight elevation of the palate or a contraction of the pharynx will entirely close the nasal passage and direct all the voice through the mouth. The palate thus becomes a valve to open or close the nares, and to be tolerated must be made with thin, delicate edges which will yield upon pressure. An instrument thus made will restore, as far as possible by mechanism, the functions of the natural organ.

Fig. 1068 represents the artificial palate separated into its constituent parts. The frame is bent at the joint in the engraving to

FIG. 1067.

FIG. 1068.



show a stop marked D, which prevents the appliance from dropping out of position. Letter C shows the tongue, which enters the groove in the plate of teeth and connects them. Letters A and B are the rubber flaps, which are secured to the frame by the hooks, as seen in the engraving. The process for making rubber wings will be found described on page 1208.

Fig. 1069 shows a more extensive palatine defect of the first class. In this case the entire soft palate is gone, together with a small portion of the hard palate at the median line. Although this defect is greater in extent, the means for its remedy are more simple. The muscles of the palate are entirely gone, and, consequently, no perpendicular movement need be provided for. The appliance in this case will resemble an elastic obturator more than the valve-like palate of the preceding one. The principle here adopted is substantially that recommended by Mr. Sercombe, of London, some years since, and consists of a plate with a set of teeth in the usual

form, and attached to its posterior edge an apron of soft rubber, which shall bridge the opening on its inferior surface, extending nearly to the pharynx. Fig. 1070 represents the set of teeth with the palate attached. In Mr. Sercombe's appliance this apron was made of the common sheet rubber in the market, prepared for other uses, and is objectionable for two reasons: 1st. A want of purity in the materials of which it is compounded, in many instances substances being used in its manufacture which would prove deleterious to the health of the patient; and, 2, its uniformity of thickness. It is far preferable, therefore, to make a mould from which to form a palate of pure and harmless materials, one which shall be of sufficient thickness in the

FIG. 1069. FIG. 1070.

central part and at its anterior edge to give stability, and yet shall have a thin and delicate boundary wherever it comes in contact with movable tissue. Such a palate may be made in a mould by substantially the same process as hereafter described. (See page 1208.) It may be secured to the plate by a variety of simple means. One, which will give as little trouble to the patient as any other, is to make a series of small holes along the edge of the plate and stitch it on with silk, or fine platina, gold, or silver wire may be used. It is desirable in this case to have the plate and palate present a uniform surface on the lingual side. In fitting the plate, therefore, it may be raised along the posterior edge from the sixteenth to the tenth of an inch, according to the thickness of the palate desired. The rubber will thus be placed on the palatine surface of the plate and present uniformity on the lingual surface.

A little thought will show that in this case the patient must educate the *muscles of the pharynx alone* to do the work of shutting off the nares, which, in the former case, was performed by them in conjunction with the muscles of the palate. Perfection of articulation will, therefore, depend upon the success of the patient in this new use of these muscles.

In cases of accidental lesions of the palate, such as are under consideration, this education of the muscles to a new work will not be difficult. The patient at some former time has had the power of distinct articulation; his ear has recognized in his own voice the contrast between his present and former condition; the ear will therefore direct and criticise the practice until the result is attained.

In the case illustrated by Figs. 1069, 1070, the defect had existed for twenty-eight years, the patient, at the time of the introduction of the artificial palate, being nearly fifty years of age. The effect upon the speech was instantaneous. Articulation was immediately almost as distinct as in youth; and this remarkable distinctness can only be accounted for upon the assumption that the pharyngeal muscles had undergone a thorough training in the vain effort to articulate without any palate.*

These two cases, chosen to illustrate the application of artificial palates in accidental lesion, have required, as will have been perceived, entire upper sets of artificial teeth in connection with the palates. This selection was purposely made because the difficulties to be overcome are much greater. In cases where there are natural teeth remaining in the upper jaw, the palate and its connection with a plate would be substantially the same, and the plate might easily be secured to the teeth by clasps in the same manner as a partial denture.

Artificial Palates for Congenital Fissure.—Congenital fissure of the palate presents far greater difficulties to be overcome than cases of accidental lesion. The opening is commonly more extensive, the appliance more complicated, and the result more problematical. Nevertheless, appliances have been made in a large number of cases which have enabled the wearers to articulate with entire distinctness, so much so as not in the least to betray the defect.

The first efforts made in this direction resembled obturators. They were simply plugs to close the posterior nares, and the results were far from satisfactory. It was not until it was recognized that the two classes of cases, accidental and congenital, were entirely distinct that much progress was made.

*An account of this case appeared in the *Argus*, of Bainbridge, Georgia, August 1st, 1868, written by the patient himself, who was the editor of that paper.

Nearly every case of accidental lesion can be treated by an obturator with considerable success; but very rarely will an obturator be of any benefit in congenital fissure, even if the congenital and accidental cases present substantially the same form of opening. For this reason much embarrassment has been thrown around these appliances within a few years past. *The character of the different classes has been confounded, and an instrument admirably adapted to one class has had claimed for it an equal application to the other class.* Let it be understood, therefore, as a rule to which there will be but few exceptions, *that congenital fissure of the soft palate requires for its successful remedy a soft, elastic, and movable appliance;* and that, with the most skillfully made instrument, *vocal articulation must be learned* like any other accomplishment. Various inventions have been made for this

FIG. 1071.

purpose within the last twenty-five years, from the most complicated one of Mr. Stearns, described in a former edition of this work, to the extremely simple one of bridging the gap with a single flap of rubber. The Stearns instrument, with all its complexity, embodied the only true principle, viz., *the rendering available the muscles of the natural palate to control the movements of the artificial palate.*

The essential requisites of an artificial palate are (1) to replace, as far as possible, the natural form of the defective organs (2) with such material as shall restore their functions. Muscular power certainly cannot be given to a piece of mechanism, but the material and form may be such that it will yield to, and be under the control of, the muscles surrounding it, and thus measurably bestow upon it the function of the organ which it represents.

Fig. 1071 represents a model of a fissured palate, complicated with

harelip on the left of the median line. There is a division also of the maxilla and the alveolar process; the sides, being covered with mucous membrane, lie in contact with each other, but they are not united. If it is desired, a very simple surgical operation can be performed which will unite both soft and hard tissues at this point of division. The left lateral incisor and left canine tooth are not developed. Fig. 1072 represents the artificial velum as viewed upon its superior surface, together with the attachment of a plate containing a clasp and two artificial teeth to fill the vacancy.

The lettered portion of this appliance is made of elastic vulcanized rubber; its attachment to the teeth, of hard vulcanized rubber, to which the velum is connected by a stout gold pin, firmly imbedded at one end in the hard rubber plate. The other end has a head, marked C, which, being considerably larger than the pin and than the corresponding hole in the velum, it is forced through—the

FIG. 1072.

elasticity of the velum permitting—and the two are securely connected. The process B laps over the superior surface of the maxilla (the floor of the nares) and effectually prevents all inclination to droop. The wings, A, A, reach across the pharynx, at the base of the chamber of the pharynx, behind the remnant of the natural velum. The wings, D, D, rest upon the opposite or anterior surface of the soft palate.

Fig. 1073 represents a model the same as Fig. 1071, with the appliance, Fig. 1072, *in situ;* the wing, D, D, in Fig. 1072, and the posterior end of the artificial velum A alone being visible in this figure.

The reader will bear in mind that the essential characteristics of this appliance are a soft, elastic substance filling the gap in the soft palate, with a flap behind as well as before, which enables it to follow all movements of the muscles with which it comes in contact, and thus perform, to a very considerable degree, the function of the fully developed natural organ.

It is this characteristic alone which made the Stearns palate a

success, and to produce which result Stearns invented the complicated and, for most cases impracticable, machinery as seen in Figs. 1079 and 1080. It was to produce the same effect by a simple appliance that the writer labored unremittingly for more than ten years, the appliance of to-day being no modification in any sense of the Stearns instrument, nor of that of any other author, but an individual and separate invention, so very simple that we can conceive of no different way by which perfection of result can be so nearly attained. A hundred instruments of like character now being successfully worn attest the writer's confidence in it. Simplicity has gone but one step further, and that has been to leave off entirely the posterior flap marked A, A in Fig. 1072. This has been done in England, France, and Germany, and occasionally in our own country, and a parade

FIG. 1073.

made of the fact, as an improvement on the inventions of the writer; but the experience of the past shows that in all these cases the makers have failed to comprehend the requirements of the case, and have, in attempting to improve the instrument, dispensed with one of its essential characteristics.

A later invention, and one which the author believes to be of almost universal application, is represented in Fig. 1074. To appreciate the importance of this invention it must be borne in mind that heretofore an instrument peculiar in form has been required for every separate case. Each appliance, being made in a mould of special adaptation, has therefore entailed upon the operator a large amount of labor.

With this later invention it is believed that with a few moulds, pro-

ducing a limited variety of palates adapted to the leading features in such cases, nearly every case of congenital cleft can be provided for upon the same principle as other forms of surgical appliance are made for general use. It was only after years of experience and the observation of many cases that the characteristics which were common to all could be determined.

Those common features are: (*a*) The fissure through the soft palate is always in the median line; (*b*) the variations, if any, from the median line are anterior to the soft palate in the palatine and maxillary bones; (*c*) thickness of the border of the fissure in the remnant

Fig. 1074.

of the soft palate is generally uniform; (*d*) the sides correspond very nearly with each other in length, breadth, thickness, and contour; (*e*) the chief variation in nearly all clefts of the soft palate is in their size or breadth, and this is true without any reference as to whether the fissure extends forward into the hard palate or not. Figs. 1071 and 1074 represent two cases of remarkable general likeness, although they differ twenty years in age and more than five years in the period of time at which they were treated.

The palate placed *in situ* in Fig. 1074 shows an instrument which, with variations in size, is of almost universal application. It is nearly identical with the palate, Figs. 1072 and 1073, were that one cut across the middle. Like the other, it is made of soft rubber, and, moreover, it will need an additional fixture to fill the gap in the hard palate and also keep the artificial velum from being swallowed. In Fig. 1072 there is a projection marked B which is made of soft rubber and is a part of the velum. This projection, as has

already been noticed, is intended to assist in supporting the velum in position. This is not always necessary or desirable; there are cases where the velum is quite as well sustained without this projection, and where, if it were applied, it would certainly injure the tone of the voice by clogging the nasal passage. In the case of Fig. 1074, if support were desired by lapping on the floor of the nares, toward the apex of the fissure, it would form a portion of the hard palate or obturator instead of being part of the velum or soft palate as heretofore.

OBTURATORS AND PALATES COMBINED.

We shall proceed now to consider another class of cases, the proper treatment of which has been followed by the most encouraging results.

For fifty years the operation of staphylorraphy has been a favorite one with surgeons, yet the number of cases in which there has been

FIG. 1075.

only a partial union are largely in the majority. In many instances all that has been accomplished is simply the tying together of a small portion of the soft palate across the back part of the fissure, leaving an opening of greater or less size through the hard palate, anterior to the newly formed septum. This opening has generally been plugged with an obturator, but vocal articulation has been little, if at all, improved. To meet this emergency a new form of artificial velum was invented. Fig. 1075 will illustrate such a case with the obturator and artificial palate *in situ*.

The patient was a man fifty years of age. The operation of

staphylorraphy had been performed twenty years previously; an obturator of silver, and afterward one of vulcanite, has been worn constantly ever since. Nevertheless, the articulation was not benefited, the reason being the same as in every other case of staphylorraphic operation, the new fleshy palate, marked A, not being long enough to close by any muscular effort the passage to the nares. There was, however, some remaining muscular action, to utilize which power was the desired object to be attained. Letter B shows the obturator, the letter C the velum. In this instance the obturator is made of soft rubber, the same as the velum, and when in use the velum is but an extension of the natural palate, as seen in Fig. 1075.

Fig. 1076 shows the appliance when not in use. The plate D secures the obturator to the teeth, as in other cases of artificial palates. In order to introduce the piece, the broad flap C should be

FIG. 1076.

first passed through the opening in the roof and pushed back; the whole fixture will readily fall into correct position. In the case of this patient, the improvement in vocal articulation was immediate and very decided.

Fig. 1077 illustrates another case of a similar character, but with incidental circumstances much more interesting. The patient was a lady, sixty-two years of age, for whom staphylorraphy was performed in 1845, by a distinguished surgeon, and the result was a remarkable success, so far as the union of the parts was concerned. The union was perfect throughout the entire length of the fissure, including the uvula; but although the patient had applied herself diligently to the improvement of her speech, she was unsatisfied with her progress. The fault being the same as in all other cases—too short a palate—the remedy must be the same. But here arose another difficulty. There was no opening through the roof of the

mouth, as in case of Fig. 1074, and there was no method of securing the desired palate extension to the inferior surface of the natural palate. To convey to the artificial velum the action of the levatores palati was essential to success. After consultation with a skillful and distinguished surgeon of this city (Dr. George A. Peters, New York), it was decided to undo, in a measure, the operation of twenty-five years before, and an opening was made through the soft palate on the median line immediately behind the hard palate, as shown in Fig. 1077. The opening was a simple straight incision,

Fig. 1077.

which was subsequently enlarged by wearing a tent for a short time. There was no pain; but little bleeding; and in a few days it was entirely healed. What complicated the case still further was the loss of all the teeth in the upper jaw, and an entire upper denture had been worn for years. The artificial palate was attached to such a denture, and, instead of proving detrimental to the denture, it was an advantage, serving, when in place, to keep the back edge of the plate from the possibility of dropping. The marked improvement in articulation and the gratification of the patient were a sufficient justification for the partial undoing of such an admirable surgical operation.

The later experience of the writer favors the idea of a partial staphylorraphic operation, with a view of making a narrow bridge across the posterior part of the fissure. Even the tying of the bi-

furcated uvula together would be of far more service to the patient than a union throughout the length of the cleft. Such a slight bridge of the gap is more easily and certainly obtained than when greater attempts are made; as the surgical operation can be supplemented by an artificial velum of a very simple character, the patient thus derives the highest benefit which surgical skill can at this day give.

Method of Making an Artificial Palate.—The success of these appliances depends very much upon the perfect accuracy of the model, since it is upon this that the parts are moulded. It is essential that the entire border of the fissure, from the apex to the uvula, should be perfectly represented in the model, as these parts are when in repose It is also necessary that the model show definitely the form of the cavity above, and on either side of, the opening through the hard palate, since that part of the cavity is hidden from the eye. It is desirable, although it is not essential, that the posterior surface of the remnant of the soft palate be shown; but it is especially important that the anterior or under surface be represented with relaxed muscles, and in perfect repose. The impression for such a model must be taken in plaster; it is the only material now in use adapted to the purpose. An ordinary britannia impression cup may be used, selecting one corresponding in size and form to the general contour of the jaw. This cup will be found too short at the posterior edge to receive the soft palate, but it may be extended by the addition of a piece of sheet gutta-percha, which must be moulded into such form as not to impinge upon the soft palate, but which will reach under and beyond the uvula, and thus protect the throat from any droppings of plaster. Before using the plaster, the posterior edge of the gutta-percha extension may be softened by heat and introduced into the mouth. Contact with the soft palate will cause it to yield, so that there is no danger of its forcing away the soft tissues when the plaster is used. The first effort will be to get only the lingual surface, taking precaution not to use too much plaster. After trial, if the impression show definitely the entire border of the fissure, and the soft palate has not been pushed up by the spasmodic action of the levator muscles, it is all that is thus far desired. If, however, the soft parts have been disturbed (which, on close comparison, a little experience will decide), it is better to take a model from the impression; and upon this model extemporize an impression cup, as described on page 1191. This temporary cup will have the advantage of the former, inasmuch as it requires but a thin film of plaster to accomplish the result, thus lessening the danger of disturbing the soft tissues. After the removal, if it is seen that any

surplus has projected through the fissure and spread out over the floor of the nares, it should be trimmed off.

In most cases such an impression will be all that is required. Such an impression can be taken, with a little experience, quite as readily as a correct impression for a set of teeth. The all-important point is to have the border of the fissure closely defined, with the soft parts hanging in their *relaxed condition*. It is not essential to one of experience that the pharynx behind the uvula should be taken in the impression. When the model is obtained from the impression, a representation of the pharynx can be made, with sufficient accuracy for practical purposes, by carving. It is only when the floor of the nares is used for the support of the palate that it becomes necessary to obtain a more complicated impression, one which shall represent not only a portion of the buccal cavity, but all the superjacent nasal cavity. When this is required, the next step will be to obtain, in conjunction with this impression of the under surface (which we call the palatal impression), an impression of the upper or nasal surface of the hard palate. This can be done by filling the cavity above the roof of the mouth with soft plaster down to the border

FIG. 1078.

of the fissure, and while yet very soft, immediately carrying the palatal impression against it and retaining it in that position until the plaster is hard, which can be easily ascertained by the remains in the vessel from which it was taken. Taking the precaution to paint the surface of the palatal impression with a solution of soap, to prevent the two masses from adhering when brought in contact, there will be no difficulty in removing it from the mouth, leaving the mass which forms the nasal portion *in situ*. With a suitable pair of tweezers this mass is easily carried backward and withdrawn from the mouth; the irregular surface of contact indicates its relation to its fellow when brought together.

Fig. 1078 will show such an impression. The portion marked A, B, C will readily be distinguished as that which entered the nasal

cavity. The line of separation from the palatal impression is plainly indicated in the engraving. The groove marked D shows clearly the impression made by the delicate uvula in the soft plaster. The nasal portion is relatively large, showing an unusually large nasal cavity. The vomer lies between the projections marked A, A, these projections entering the nasal passages. The surfaces marked B, B come in contact with the middle turbinated bones; the surface marked C in contact with the inferior turbinated bone. In many instances these turbinated bones are so large as nearly to fill the nasal passages.

The method of obtaining a model of the mouth from this impression does not require any particular description. The process is similar to the making of a cast into any other mouth impression. The model represented in Fig. 1077 shows a convenient form for such a case.

When the nasal portion of the impression does not indicate the superior surface of the soft palate, the part may be represented in the model by carving. It is not essential to the success of the artificial palate that the posterior surface of the soft palate should be represented with the same accuracy that is required on the inferior surface or on both surfaces of the hard palate. By the aid of a small mirror and a blunt probe the thickness of the velum and the depth behind the fissure can be ascertained; approximate accuracy is sufficient, since the portion of the artificial palate coming in contact with it is so elastic that it easily adapts itself to a slight inequality, rendering absolute accuracy less important.

The next step will be the formation of a model or pattern of the palate. Sheet gutta-percha is preferable for this purpose, although wax or some other plastic substance might answer. The form which should be given is better indicated by the drawing, Figs. 1072 and 1083, than it could be by written description. The Stearns instrument, of which a cut is here given (Figs. 1079 and 1080), was made to embrace the edges of the fissure and was slit up through the middle, so that when the edges of the fissure approached each other, as they always do in swallowing, the two halves of the instrument would slide by each other; a third flap or tongue was made and supported by a gold spring, to cover and keep closed this central slit.

This complicated provision for the contraction of the fissure is entirely superseded in Figs. 1072 and 1083 by making the instrument somewhat in the form of two leaves, one to lie on the inferior and the other upon the superior surface of the palate, and joined together along the median line. When the fissure contracts, the halves of the

divided uvula slide towards each other between these two leaves. The posterior portion, marked A in Fig. 1072, is made very thin and delicate on all its edges, as it occupies the chamber of the pharynx, and is subject to constant muscular movement. The sides are rolled slightly upward, while the posterior end is curved downward. The inferior portion, marked D, D, should reach only to the base of the

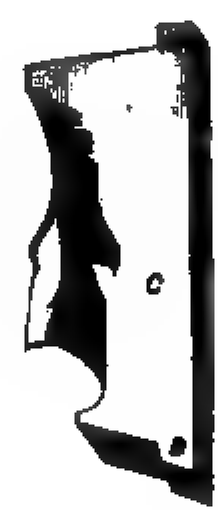
Fig. 1079. Fig. 1080.

uvula, and bridge directly across the chasm at this point (Fig. 1073); and no effort to imitate the uvula should be made. The extreme posterior end should not reach the posterior wall of the pharynx by a quarter of an inch when all the muscles are relaxed (although subsequent use must determine whether to increase or diminish this space), thus leaving abundant room for respiration and for the passage of nasal sounds. In cases where it is desirable to make the instrument, as far as possible, independent of the teeth for its support, the anterior part which occupies the apex of the fissure in the hard palate may lap over upon the floor of one or both nares. Such a projection is seen in Fig. 1072, marked B, and a like process is seen in Fig. 1083, but not lettered. Were it not for this process in the first case, the palate would drop from the fissure into the mouth, the single clasp at the extreme anterior edge not being sufficient to keep the whole appliance in place throughout its entire length. Caution must be exercised that this projection entering the nares be not too large, or it will obstruct the passage, and give a disagreeable nasal tone to the voice.

All the peculiarities described must be provided for in the gutta-percha model, which after having been carefully formed upon the cast, may be tried in the mouth, to ascertain its length or necessary variations. When its ultimate form has been determined, provision must be made to duplicate it in soft rubber. A familiar illustration of the process here to be adopted is found in the parallel process employed when a set of teeth is made on the vulcanite base. A model form is made of wax and gutta-percha, bearing the teeth, and in all its prominent characteristics has the shape desired in the completed denture, the rubber duplicate being vulcanized in a plaster mould. In like manner the rubber duplicate of the palate, as before described, may be made in a plaster mould.

If plaster is used for the moulds, it must be worked so that the surface shall be free from air bubbles, or the rubber palate will be covered with excrescences that cannot readily be removed. By covering the surface of the mould with collodion or liquid silex, it

FIG. 1081.

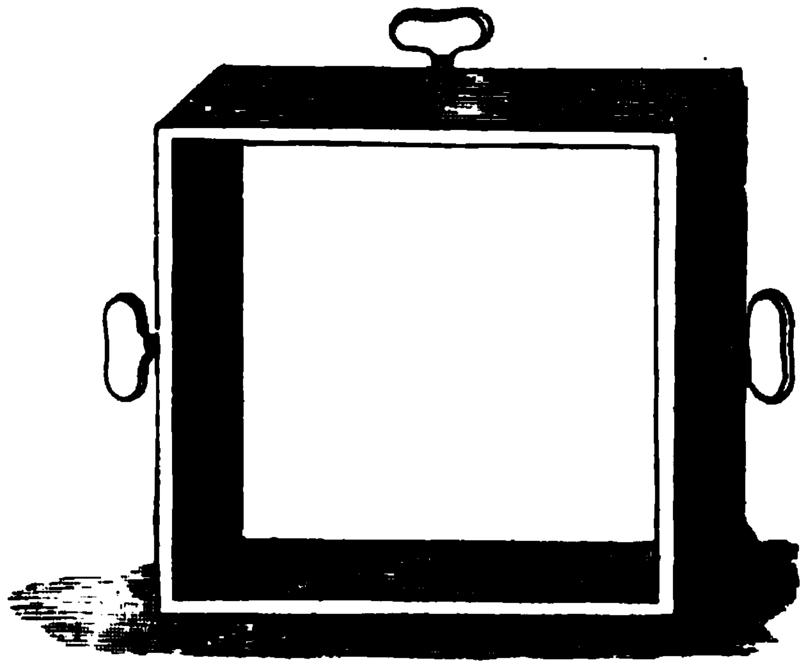


will be much improved. But, ordinarily, plaster moulds will be found too troublesome for general use. They may be put to a most excellent use, however, by using one to make a duplicate of the gutta-percha in hard rubber. This is not necessary with those who have had much experience, but with beginners it will be difficult to work up the gutta-percha as nicely as may be desired; a duplicate in vulcanite will enable the operator to make a more artistic model of the palate, and one which can be handled with greater freedom.

As in the course of a lifetime a considerable number of elastic palates will be required, the mould which produces them should be made of some durable material. The type metal of commerce

is admirably adapted to this use. A very complete mould is one made of four pieces which will produce a palate in one continuous piece. Such a mould requires very nice mechanical skill in fitting all the parts accurately, and unless the operator has had experience in such a direction it is better to simplify the matter. Fig. 1081 shows a mould in four pieces. The blocks C, C are accurately adapted to the body of the mould marked A, and are prevented from coming into inaccurate contact with each other by the flanges D, D, which overlap and rest upon the sides of the main piece. B shows the top of the mould,

FIG. 1082.



and the groove E provides for the surplus rubber in packing. Such a mould makes as perfect an appliance as can be produced. The palate is one homogeneous and inseparable piece. The cut will sufficiently indicate the form of the several parts. Each of these pieces is first made in plaster, having exactly the form desired in the type metal. They are then moulded in sand, and the type metal cast as in

FIG. 1083.

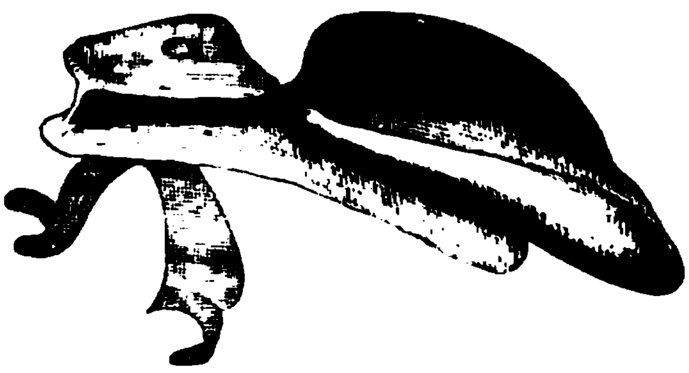
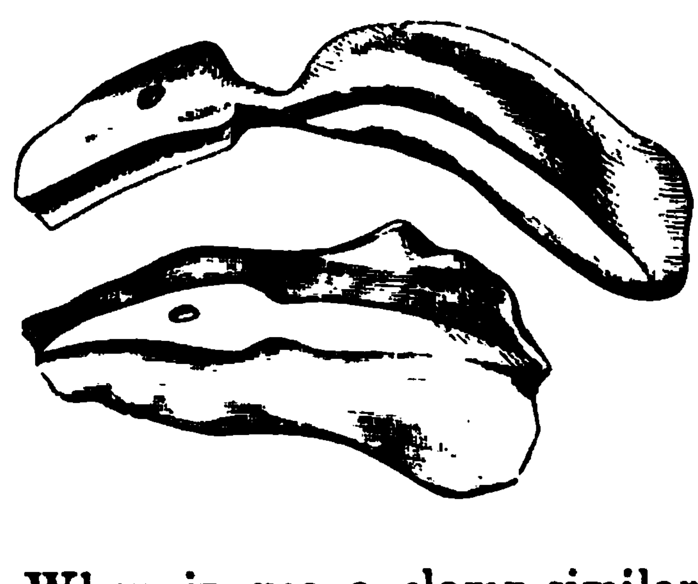


FIG. 1084.



making an ordinary die for swaging. When in use a clamp similar to Fig. 1082 is placed around the mould to keep the several parts firm in their position.

Fig. 1083 shows the palate complete with its attachment to the

teeth. The palate is secured to the plate by a pin of gold passing through a hole of the same size in the palate, the head on the pin being larger than the hole through which it is forced.

By making the palate in two pieces to be joined after vulcanizing, as shown in Fig. 1084, the mould may be made in only two pieces and with very little trouble. When in use the two pieces, as here represented, are bound together at the forward part by the gold pin before referred to, and a few stitches of silk secure it at the posterior part.

The instrument then becomes identical with that shown in Fig. 1083.

Fig. 1085 shows the mould or flask in which it is vulcanized. These flasks were made expressly for this purpose; but they are not

Fig. 1085.

so unlike the flasks in common use in dentists' laboratories that the latter will not answer. The common flask is simply unnecessarily thick or deep.

The mould is readily produced in the following manner: Imbed the two pieces of the palate in the plaster in one-half of the flask; when the plaster is set and trimmed into form, duplicate it in type-metal by removing the palate, varnishing the surface, moulding in sand, and casting. In making the sand mould, take a ring of sheet iron of the same diameter as the flask and three or four inches high; slip it over the flask and pack full of sand. Separate them, remove the plaster, return the flask to the sand mould, and fill with the melted metal through a hole made in the side or bottom of the flask. Having thus made one-half, substantially the same process will produce the counterpart.

Fig. 1086 shows the mould which produces the palate illustrated

by Fig. 1074. It is the most simple and at the same time the most complete of any mould yet invented. The mould is made in three pieces, and is inclosed in a flask exactly the same as Fig. 1085, but with this improvement: the latter mould yields a piece formed of two separate parts of rubber, which must be afterward joined by stitching or otherwise; while the former (Fig. 1086) produces an appliance in one piece, and as perfectly finished as by the more complicated mould of four pieces, shown in Fig. 1081. Letter A represents the base of the mould; B, the middle section, which is placed on the top of A; and the third section, or top, C, completes it.

FIG. 1086.

The mechanical process by which this mould is made is substantially the same as given for making those before described. The packing of the mould with rubber should be done in the same manner as when hard rubber is used for a dental base, with which process it is assumed that the reader is familiar. By washing the surface of the mould with a thick solution of soap previous to packing, the palate will be more easily removed after vulcanizing. The rubber used for this purpose must be a more elastic compound than that for a dental base-plate. The composition used for the elastic fabrics of commerce will answer, if made of selected mate-

rials. There is also on sale at the dental depots a soft, elastic compound admirably adapted to the purpose, with accompanying instructions for vulcanizing; the best results being obtained by heating up to 230°, and gradually increasing during four or five hours to 270°.

THE END.

INDEX.

Single references will be found under leading word of title; many subjects are referred to under each word of title, and sometimes under its synonym. Principal subjects are alphabetically arranged; but details and subdivisions are usually given in the order of description in the text, so as to present a full synopsis of the subjects indexed.

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